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Detailed Design Specification for Product Three—Significant Soldier Characteristics

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This report represents a detailed design specification for a computerized aid that estimates the characteristics of personnel likely to be available to man a weapons system before it has been fully designed. The aid deals with two classes of human characteristics, those that are MOS dependent, and those that are not. MOS-dependent characteristics are usually related to cognitive skills; MOS-independent characteristics are those related to size, strength, and perception. This aid was developed using the Revelation data base management system. It contains software architecture, data requirements, and interface design. This design specification, one of several that are part of a larger U.S. Army Research Institute research program, will not be developed, but it may prove useful for other projects.

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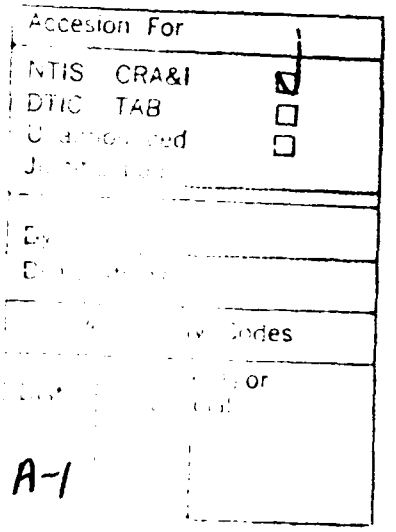

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DETAILED DESIGN SPECIFICATIONS FOR PRODUCT THREE--SIGNIFICANT SOLDIER CHARACTERISTICS

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DETAILED DESIGN SPECIFICATION FOR PRODUCT THREE--SIGNIFICANT SOLDIER CHARACTERISTICS

1.0 SCOPE

The goal of MANPRINT Product 3 is to conceive, design and implement a software system to assist Army human factors specialists in the specification of soldier characteristics of importance to weapon and support system hardware designers. Product 3 shall have the capability of leading a human factors specialist to pertinent characteristics based on a taxonomic description of the system being specified. The proposed software system shall also have a number of features designed to improve its usefulness, including the ability to: (1) save, edit, and print every screen display in the design search process, (2) perform user-defined analyses and evaluations of data, 3) intelligently modify and add to the data bases, either from the keyboard or from mass storage devices, and (4) access extensive on-line help and tutorial facilities. Such features, along with the basic functionality, enable Product 3 to permit easy but comprehensive design searches by professionals not trained in computers.

This specification covers the top level and detailed software structure of a proposed MANPRINT Product 3. It includes both general and detailed software design requirements for the development of the proposed system. The design is based on the concept paper submitted in response to Phase I of the MANPRINT program. The top level software components are as follows: the design aid interface component, the search process record component, the analysis component, the knowledge acquisition interface component, the training/help component, the alphanumeric data base component, and the graphics data base component. These components constitute the entirety of the MANPRINT Produce 3 software system. The hardware and requirements are as defined in the integration rules provided by the Army Research Institute,as referenced in Appendix I, System Integration Guidelines. The software language requirements are in accordance with guidance from the Army Research Institute, as referenced and expanded upon in Appendix II, Language Specification. This document is intended to be used in the development of the MANPRINT Product 3 software system during Phase 3 of the contract.

In addition to the primary authors listed for this specification, substantial assistance was rendered by the following American Institutes for Research personnel: Lauress L. Wise and David L. Winter in the area of data file identification and specification; Donald H. McLaughlin in the design of the overall software architecture; and Mildred Jarvis and David S. Dow in the organization and preparation of the final report.

2.0 APPLICABLE DOCUMENTS

The following documents, of the exact edition shown, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement. In this specification references to paragraphs of this specification and of applicable documents invoke all subparagraphs except where specific subparagraphs are excluded.

2.1 Government Documents

2.1.1 Standards

MIL-STD-1472C 2 May 1981 Notice 1 1 September 1983 Notice 2 10 May 1984 Notice 3 17 March 1987	Human Engineering Design Criteria for Military Systems, Equipment and Facilities Section 5.15

2.1.2 Regulations

AFR 161-35 9 April 1982	Hazardous Noise Exposure

2.1.3 Handbooks

MIL-HDBK-759 30 June 1981	Human Factors Engineering Design for Army Material
AFSC DH 1-3 1 December 1982	Human Factors Engineering
AFSC DH 2-8 14 October 1983	Life Support

2.1.4 Other Documents

ESD-TR-86-278 August 1986	Guidelines for Designing User Interface Software
AFAMRL-TR-85-013 January 1985	Person Computer Dialogue: A Human Engineering Data Base Supplement

2.1.5 Texts and Journals

Boff, K.; Kaufman L.; Thomas, J.	Handbook of Perception and Human Performance
Dumas, J. 1987	Designing User Inerfaces for Software
Fraser, L. 1966	The Effects of Confinement as a Factor in Manned Space Flight (NASA -CR-511)
Jones, F; Prince, A. 1964	Man's Function in Military Space Systems (McDonnell Douglas Report A-507)
Parker, J; West, V. 1973	Bioastronautics Data Book (NASA-SP-3006)
Schowalter, D.; Malone, J. 1972	The Development of a Lunar Habitability System (NASA-CR-1767)
Woodson, W. 1981	Human Factors Design Handbook

3.0 DESIGN REQUIREMENTS

3.1 Top Level Design Requirements

3.1.1 Software Architecture

The software components listed below shall constitute the entirety of the MANPRINT Product 3 software system and shall provide the capability to interact with the hardware requirements as defined in Appendix I, provided by the Product Integration Rules, Army Research Institute, 31 July 1987. Figure 3-1 provides a diagram of the components showing the relationship of the components to one another. The seven top level software components shall be:

a. Design Aid Interface Component

b. Search Process Record Component

c. Analysis Component

d. Knowledge Acquisition Interface Component

e. Training/Help Component

f. Alphanumeric Data Base Component

g. Graphics Data Base Component

3.1.1.1 Design Aid Interface Component

The Design Aid Interface top level software component shall provide the capability to access system information and utilities, guide the user through a design aid session, and control access and data flow to all other top level software components. The Design Aid Interface component shall function as the primary user-system interface. Logging on shall bring the user directly into the Design Aid Interface component. The Design Aid Interface shall automatically display, upon system initialization, the top level menu, from which the user may select access to system functions. At a minimum, the Design Aid Interface Component shall provide the capability to:

a. Access and retrieve all alphanumeric and/or graphic information available on the soldier characteristics that affect the design of the system under consideration.

b. Access a sample design aid session.

c. Obtain on-line help information to assist in the design search process.

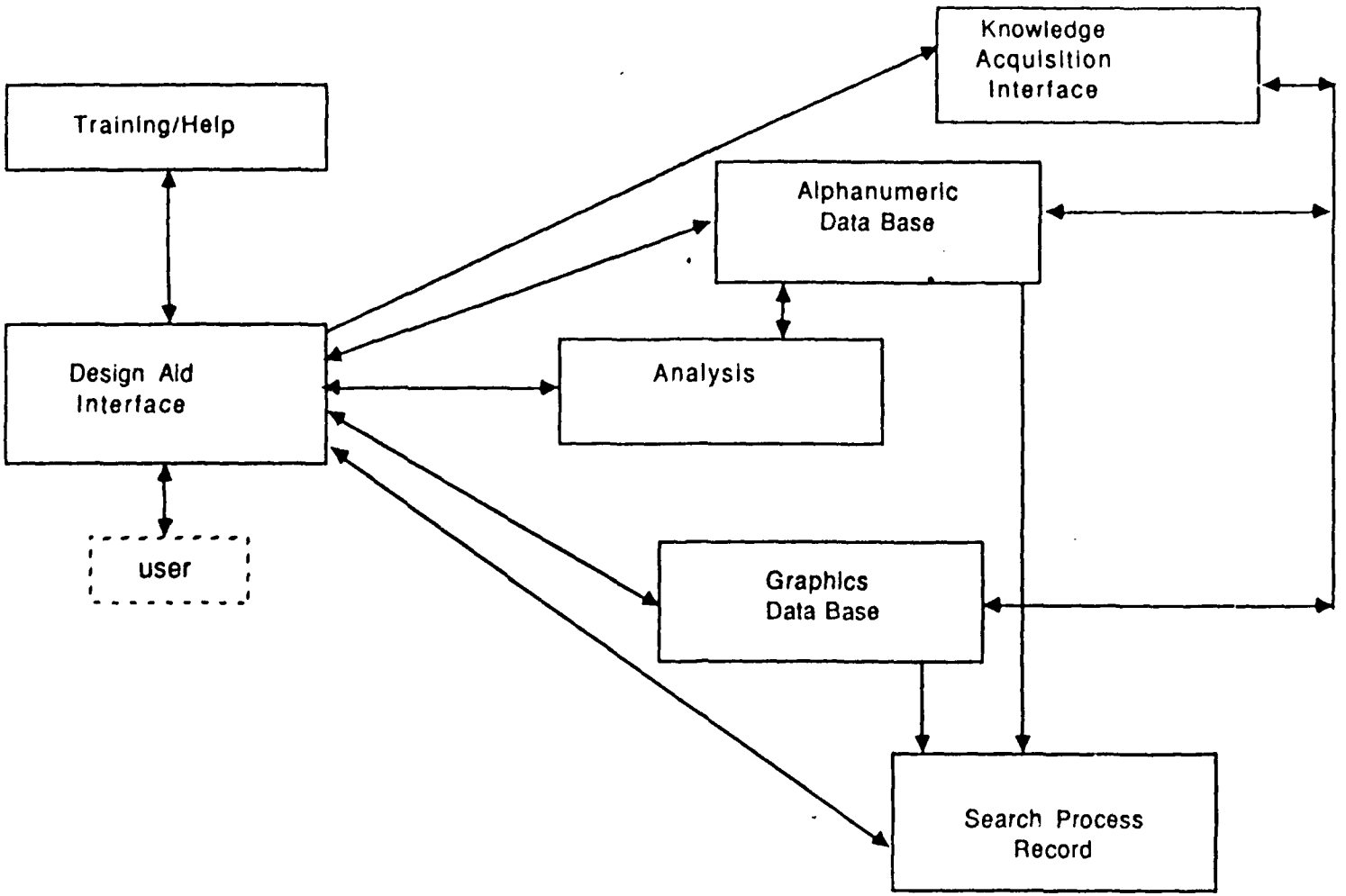

Figure 3-1 Top Level System Functional Diagram

d. Add, delete, or modify existing soldier characteristic alphanumeric data files.

e. Add or delete bit-mapped soldier characteristic graphic files.

f. Access existing analysis routines.

3.1.1.2 Search Process Record Component

The Search Process Record top level software component shall automatically retrieve and store copies of soldier characteristics alphanumeric and graphic data base materials accessed by a user during a design aid session, including all input and output screen displays associated with the retrieval process. The Search Process Record shall provide the capability for the user to:

a. Access all design aid session-specific data any time during the design aid session for review and/or editing.

b. Provide the user the option to save design aid session outputs to the system hard disk or on a floppy disk, as desired.

c. Recall design aid session data and screens at a future time for review and/or editing.

3.1.1.3 Analysis Component

The Analysis top level software component shall maintain and control Product 3 analytic routines as required to support user-initiated transformation and manipulation of information contained in the Alphanumeric Data Base component. The Analysis component shall have the capability to call for and apply individual statistical operations to designated data base files. As a minimum, the following parametric and nonparametric statistical operations shall be provided:

a. Descriptive statistics.

b. Parametric and nonparametric correlations (Pearson and Spearman).

c. Transformations (linear and nonlinear algebraic).

d. Time series (moving average and autoregressive-moving average (ARIMA)).

3.1.1.4 Knowledge Acquisition Interface Component

The Knowledge Acquisition Interface top level software component shall provide the functional capability to update the Product 3 alphanumeric and graphics data bases. There shall be two modes of data entry: manual and automatic. The manual mode shall provide the capability to add new alphanumeric data files, modify, and/or delete existing data files directly from the workstation keyboard. The automatic mode shall provide the capability to update Alphanumeric/Graphic data files via compatible floppy disks and/or Bernoulli removable disks.

3.1.1.5 Training/Help Component

The Training/Help top level software component shall provide the functional capability for users to obtain assistance in two areas:

a. Training

The training function shall provide the capability for the user to:

(1) access and view a sample design aid session, with no technical inputs required from the user.

(2) access and view a demonstration of all functions of the system to provide the user with an understanding of the functionality of the system and to obtain a cognitive model of the system operation.

b. Help

The help function shall be integrated with and encompass all Product 3 user-system interface operational and maintenance activities, including but not limited to those associated with the Design Aid Interface, Search Process Record, Analysis, and Knowledge Acquisition Interface components. Help prompts and/or access to the help functions shall be an integral element of all display screens. Prompts shall be designed to assist the user in determining the function of and inputs required for system operational and maintenance activities. Help screens shall describe the present location in the search process and briefly outline the legal paths available to the user. All help and prompt text shall be in plain English and easily understood by the user, without need for translation. In addition, a glossary of terms used throughout the MANPRINT programs shall be available to the user.

3.1.1.6 Alphanumeric Data Base Component

The Alphanumeric Data Base top level software component function shall be to store and control all information on soldier characteristics available to the

system, with the exception of the terminal graphics displays as defined in the Graphics Data Base component. This information shall be maintained in formatted or unformatted text files on the hardware system's mass storage devices as defined in the hardware integration requirements. This component shall not be directly accessible to the user; however, the user shall have indirect access to all information contained in the data base through the Design Aid Interface, Analysis, Search Process Record, or Knowledge Acquisition Interface components.

3.1.1.7 Graphics Data Base Component

The top level Graphics Data Base software component function shall be to store and control all terminal user interfaces not explicitly reserved for one of the other components. These interfaces shall consist of all charts, graphs, and drawings depicting information directly available to the user during a design aid session. This information shall provide the user with graphic data on soldier characteristics pertinent to the design of the system being specified. This component shall not be directly accessible to the user; however, the user shall have indirect access to all information contained in the data base through the Design Aid Interface, Analysis, Search Process Record, or Knowledge Acquisition Interface components.

3.1.2 Functional Allocation

The functional allocations to top level software components shall reflect the decomposition of system functional requirements as evidenced in the designated software architecture to support Product 3 ease of system access, ease of usability, and simplicity and reliability of design for system operation and maintenance. Table 3-1 provides a verification table relating system requirements as specified by the Government to the top level software component that is assigned to fulfill each requirement.

3.1.3 Memory and Processing Time Allocation

3.1.3.1 Memory Allocation

The MANPRINT Product 3 software system shall operate on the hardware suite as defined in the hardware integration requirements listed in Appendix I. The Revelation data base management system shall run on top of the DOS specified in the requirements. The exact system language and support software requirements shall be as specified in Appendix II. The memory management facilities of Revelation shall enable Product 3 to run well within the 640K bytes of main (unmapped) memory, which is the memory limit of 80286 machines running MS-DOS. However, Revelation shall also be able to take advantage of a larger quantity of mapped memory as defined by the Extended Memory Standard (EMS). The addition of a RAM disk running in mapped memory will enhance the execution time of all modules and increase the speed of data searches, since a greater portion of the software will be

Table 3-1. Functional Requirements Verification

Requirement	Top Level Software Component						
	DAI	SPR	ANA	KAI	T/H	ADB	GDB
Operating System							
MS DOS 3.2 *							
Data Base Management							
System Revelation/Pick *							
Other System Software							
Turbo C *							
Utilities *							
Encryption **							
Comm between products	X						
User Interface	X		X				
Menus	X		X				
Language							
Command	X						
Natural	X						
Glossary	X						
Mouse	X						
Saving and return		X					
Color coding **							
Function keys	X						
Housekeeping	X	X					
Display colors	X						
File selection				X			
Device drivers	X	X					
Training					X		
Help					X		
Editing		X					
File Generation		X	X				
Graphics	X						X
Printing		X					
Soldier Characteristics						X	X
File Modification				X			

* See Appendix II

** Not applicable

DAI- Design Aid Interface
ANA- Analysis
T/H- Training & Help
GDB- Graphics Data Base

SPR- Search Process Record
KAI- Knowledge Acquisition Interface
ADB- Alphanumeric Data Base

able to be loaded into memory prior to execution, and therefore greatly reduce disk searches. All software components shall execute entirely in main (unmapped) memory, while data files shall be swapped between mass storage and main memory as required for execution of the individual components. The design goal shall be that the object code residing in main memory shall be no greater than 275K bytes. Allocation to individual top level components shall be as follows:

a. Design Aid Interface: 100K bytes.

b. Search Process Record: 25K bytes.

   This shall not include the dynamic data structure as described in 3.2.3.2.2. Appended search files will be saved to disk in a temporary file; thus, the maximum size of a search process record is defined by the amount of disk or mass storage available.

c. Analysis: 110K bytes.

   Analysis routines shall be a series of executable modules outside of Revelation to be run from within Product 3 when explicitly called by the user. Only the single module being executed at a particular point in time will be in main memory. No individual analysis module shall be larger than 25K bytes of object code.

d. Knowledge Acquisition Interface: 35K bytes.

e. Training/Help: 40K bytes.

f. Alphanumeric Data Base: No segment of a data file shall be larger than 50K bytes.

   Only the data files actively in use during Product 3 operations shall be running in main memory.

g. Graphics Data Base: No data file shall be larger than 16K bytes.

   Only the graphics files actively in use during Product 3 operations shall be running in main memory.

3.1.3.2 System Response Times

The MANPRINT Product 3 software program shall operate within the maximum acceptable response times listed below:

a. From end of user-input request to see next screen until response is first visible: 1.0 seconds.

b. From selecting a field until visual verification: .2 seconds.

c. From entry of user-input request until display of prompts, help instructions or error messages: 2.0 seconds.

d. From entry of user request to first appearance of analysis calculations in graphic form: 10.0 seconds.

e. From selection of a function until the functions responds: 2.0 seconds.

3.1.4 Functional Control and Data Flow

3.1.4.1 Functional Control

The user shall initialize the system and perform design aid session activities, data update activities, or conduct system software maintenance activities via the Design Aid Interface component, which shall be the primary user-system control point and interface for the entire software system. To accomplish specific functions not available in this component, the Design Aid Interface shall transfer control to one of the other components as required; however, upon completion of the designated function, control shall always return to the Design Aid Interface. Specifically, the Design Aid Interface shall permit transfer of control for the specified functions to the following components:

a. Search Process Record.

b. Analysis.

c. Knowledge Acquisition Interface.

d. Training.

3.1.4.2 Data Flow

Data flow in Product 3 shall be controlled by user input. Control between user-accessible top level components shall be directed entirely by the user. Data flow between the user and user-accessible components shall be primarily through cursor and menu control action. Data flow between top level software components shall be primarily through pointers accessing data files. A complete top level data flow diagram is contained in Figure 3-2.

3.1.5 Global Data

All data that reside in the Alphanumeric and Graphics Data Bases shall be defined as global data. Global data shall be permanent, unless modified or deleted through the Knowledge Acquisition Interface functions. These data shall be accessible by any of the components that interact with the user. Global data requested during a design aid session shall be copied by the Design Aid Interface and passed to the Search Process Record component

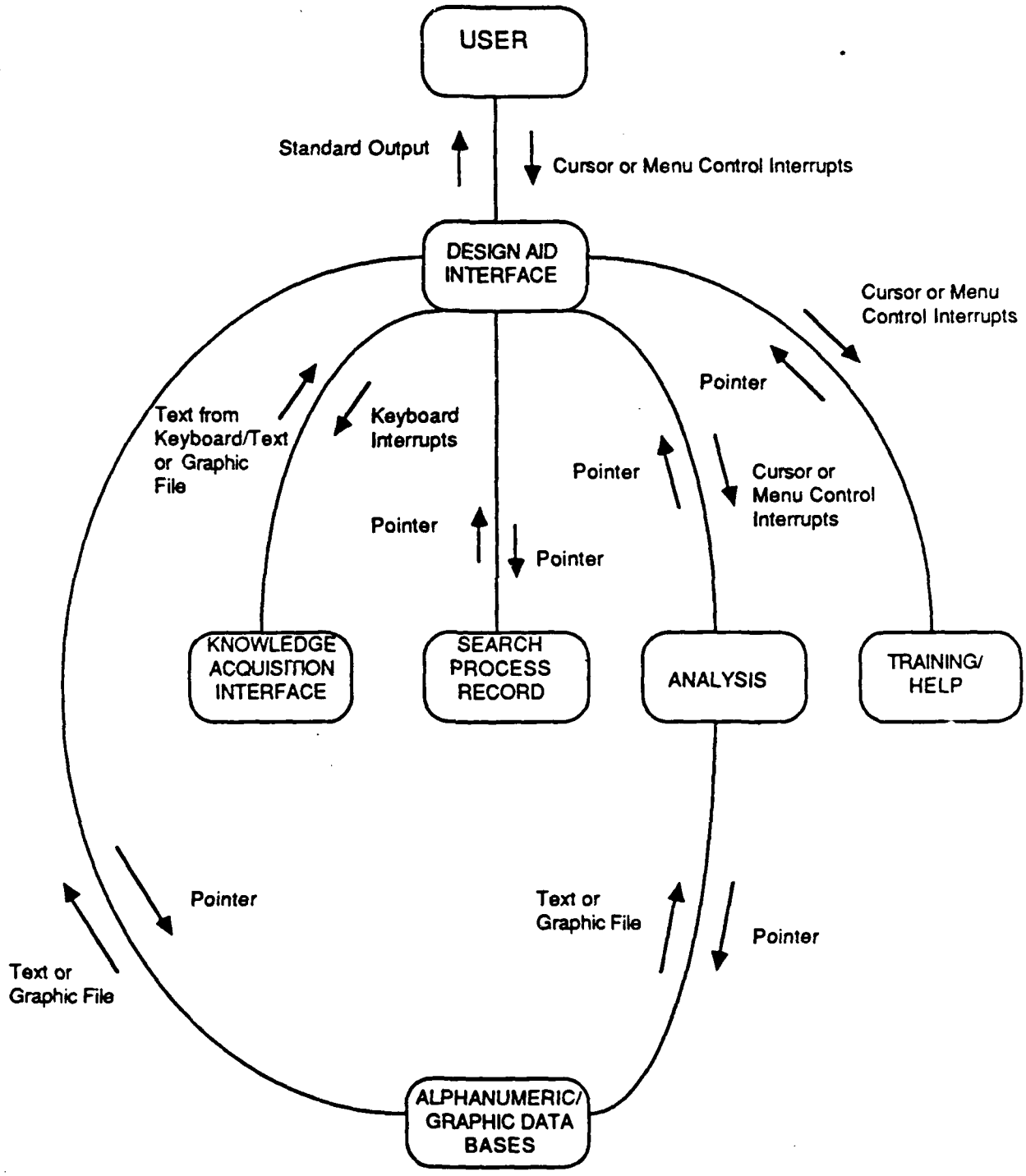

Figure 3-2. Top Level Data Flow Diagram

and appended to the Search Process Record list for later review. All other data shall be considered to be local, created by a single component sometime during its execution, and destroyed when execution of that component is complete and control is transferred elsewhere.

3.1.6 Top Level Design

3.1.6.1 Design Aid Interface TLSC

3.1.6.1.1 Purpose

Given the appropriate user inputs, the Design Aid Interface component shall:

a. Control the search and extraction of information on soldier characteristics by MANPRINT personnel, as necessary to select and display appropriate design aid session information.

b. Request execution of statistical routines.

c. Retrieve and display help messages as required to assure entry of legal values and to recover from entry syntax errors.

d. Provide the capability to control and display, as required, the manual addition, modification, and/or deletion of global data bases, and search process records.

3.1.6.1.2 Objective

The objective shall be to provide the user with a complete set of system menus, displays, prompts, and help messages for use in design aid sessions and for manual entries associated with updating the system data bases and/or system software. Product 3 user-system interface requirements shall be designed in accordance with the requirements of Appendix III. Design implementation shall include, but not be restricted to:

a. Easy-to-use system menus.

b. User selection of the hardware entry device of choice (keyboard, cursor, or mouse).

c. User capability to return to the previous menu, the top level menu, or the help function.

3.1.6.1.3 General Description

User interaction functions shall be fully transparent to the user, while system controlling and accessing functions shall be entirely hidden from the user. Command language shall not be used at any point in the user interface. The Design Aid Interface shall provide the internal software routines to allow:

a. Direct user-system interactions through presentation of menus and information on display screens.

b. Execution of user entry device input signals.

c. The controlling of access, including transfer of control and return of control between the Design Aid Interface and other top level software components.

3.1.6.1.4 Inputs

During a design aid session, the Design Aid Interface shall have the capability to accept the following types of input:

a. Data supplied by the user in directing a search process during a design aid session. The user shall have the option to input keystrokes directing the selection of individual options from the menus via cursor or mouse control or by entry of 3-5 character alphanumeric sequences indicating the selection of a level in the taxonomy of a particular data file.

b. Global data extracted from the Alphanumeric and Graphics Data Bases and transferred to the Design Aid Interface. Inputs from the Alphanumeric Data Base shall be in the form of ASCII files. Inputs from the Graphics Data Base shall be in the form of bit-mapped graphics files, which shall be stored in compressed form and expanded prior to display.

c. Training presentation display screens and text.

d. Help messages and displays.

e. Statistical and data manipulation outputs from the Analysis component.

f. Confirmation of instructions and/or executions by the Knowledge Acquisition Interface component.

3.1.6.1.5 Local Data

Local data shall be limited to those sets of data created as a result of internal component manipulations (e.g., placeholders for keystrokes that indicate the search through the information taxonomy or the transfer to a help screen). No locally created data shall be displayed to the user and shall be destroyed upon transfer to another component or when additional memory is required for other operations.

3.1.6.1.6 Sequencing

The Design Aid Interface component shall always be the first executed upon system initialization. The Design Aid Interface shall remain active at all times during a design aid session unless user inputs initiate a transfer of control to another top level software component. Control shall always transfer from another component after its completion back to the Design Aid Interface component. The Design Aid Interface shall also control system termination.

3.1.6.1.7 Processing

The Design Aid Interface processing capabilities shall include data manipulation by algorithms, special control features, and error handling.

a. Algorithms

   The inputs into the Design Aid Interface shall be manipulated internally to form a directed graph structure that shall provide a pathway to the the appropriate data base file or files. Given a directed graph structure in sufficient detail to make a comparison between the requested information and the contents of a particular data file, the bottom node of the graph shall provide the key into the appropriate data file.

b. Special Control Features

   Using menu selection items, the user shall have the capability to change display screen background and alphanumeric character colors.

c. Error Handling

   All inputs shall be checked for proper syntax and legal values upon entering into the system. Errors in syntax, legal values, and requests for nonexistent global data files shall suspend program execution and relay an appropriate message back to the user. Upon receipt of an error message, the user shall automatically be presented with the appropriate help information, instructions, or legal values. For nonexistent data files, the user shall have the capability to request a listing of all legal data files.

3.1.6.1.8 Outputs

Output from the Design Aid Interface shall consist of:

a. Display of all system screens, including global data from the system data bases, menus, help, training, and system update and software maintenance screens. All sources shall be output to the standard

output device in either a text (for text files) or bit-mapped (for graphics files) format.

b. Execution commands to other output devices (e.g., disk storage devices or printers).

3.1.6.2 Search Process Record TLSC

3.1.6.2.1 Purpose

The Search Process Record shall provide the user access to duplicated data files and screens that record the results of the search process steps taken during a single design aid session on Product 3. Design aid session results shall be accessible to the user (via the Design Aid Interface) to enable the user to examine and/or edit the materials during the session or at a future time, if the user has designated that the record be saved. Design aid session results shall be accessible to the user via screen display or as hard copy output and shall consist of the total set of results or selected portions of the results, as designated by the user.

3.1.6.2.2 Objective

The objective of the Search Process Record component shall be to receive, duplicate, store, and format for output to the Design Aid Interface component alphanumeric and graphic data base files and screens. The user shall have the capability to review and/or edit the files at any time during the design aid session or at a future date. If the user has not designated that the design aid session data be saved, the data shall be deleted upon termination of the design aid session.

3.1.6.2.3 General Description

The Search Process Record shall be composed of a linked list of text and graphic screens created by the Search Process Record component and added to through the Design Aid Interface component. Each screen display shall be a sequential copy of the equivalent display presented to the user. The Search Process Record shall be fully editable via a full screen editor at any time during the conduct of a design aid session. Both intermediate and final Search Process Record products can be saved to floppy or hard disk, or printed in hard copy.

3.1.6.2.3.1 Data Handling

The Search Process Record shall create a linked list at the initiation of any design aid session upon which alphanumeric and graphic data shall be appended and saved for manipulated later in the search process. The list shall store all data, analytical results, and associated retrieval displays in a manner that will provide the user with a sequential record of search materials. The Search Process Record shall provide the capability to display one

graphic at a time, along with its accompanying data base information, if any. At any time during the design aid session data review/edit process, the user shall have the capability to return to the design aid information search mode, whereupon the Search Process Record shall continue to automatically add the search results sequentially to the linked search list at the point of previous exit from that record. Re-entry to the Search Process Record after further searches shall be at the same point at which exit occurred. At any intermediate point in the view and edit process, or at the conclusion of all search effort, the edited file shall have the capability of being saved to disk and control returned to the Design Aid Interface. Printing of the output shall be possible from within the Search Process Record itself.

3.1.6.2.3.2 Editing Capability

During a design aid session, selection of the search process record feature shall permit the user to move through the previously searched files, one step at a time, to review and/or edit the material. The editor shall provide the user with the capability to cut and paste text or entire files, and shall include:

a. Full screen editing capabilities, including the ability to remove the entire alphanumeric/graphic data combination from the Search Process Record, remove only the graphic and leave the alphanumeric data, remove the alphanumeric data and leave only the graphic, or make any modifications to the alphanumeric data.

b. Editing of sections where the design effort does not require the amount of detail provided, and otherwise prepare the records for hard copy output.

3.1.6.2.4 Inputs

The Search Process Record shall receive inputs from three sources:

a. The Alphanumeric Data Base component;

b. The Graphics Data Base component; and

c. The Design Aid Interface component.

3.1.6.2.4.1 Data Base Inputs

The major inputs shall be from the Alphanumeric and Graphics Data Base components. The Search Process Record shall extract text files from the alphanumeric data base and bit-mapped graphics files from the graphics data base, as directed by user design aid session inputs. These files shall be appended in sequential order to a linked list originating within the Search Process Record component.

3.1.6.2.4.2 Design Aid Interface Component Inputs

The Design Aid Interface component shall input its menu and data input screen to this component, which shall also be appended in sequential order to the linked list. These inputs shall be bit-mapped representations of the actual menus hard-wired into the Design Aid Interface. The user shall have a full screen edit and a print capability through the interface with the Search Process Record. This capability shall allow for the input of instructions for the cutting and pasting of text or of entire files (linked list nodes) in the record, and allow for the hard copy output of all or part of the record.

3.1.6.2.5 Local Data

Local data within the Search Process Record shall be limited to the structures required for the creation and modification of the current design aid session linked list, and for the execution of the full screen edit and print functions.

3.1.6.2.6 Sequencing

The Search Process Record component shall be entered only from the Design Aid Interface component. No other user-accessible component shall be entered from the Search Process Record. Exit from this component shall be to the Design Aid Interface only.

3.1.6.2.7 Processing

a. Algorithms

The primary algorithm used in the Search Process Record component shall be the dynamic memory allocator and linker that accepts each item to be added to the record and appends it onto the directed graph.

b. Special Control Features

Not Applicable.

c. Error Handling

The Search Process Record may have two types of errors: overflow of memory space and editing errors.

(1) Overflow of Memory Space

Memory overflow errors may occur when the record is composed of dynamically allocated memory and not saved to disk. When memory reserve has reached 10% of main memory, a message shall be sent to the user, with instructions

to either save the Search Process Record to disk, or to enter the Search Process Record component and edit the record.

(2) Editing Errors

Text and/or graphics editing errors, (e.g., attempts to edit an empty file, copy too large an area of text, etc.) shall cause the Search Process Record execution to suspend and an appropriate error message shall be transmitted to the user, accompanied by identification of the probable error.

3.1.6.2.8 Outputs

The Search Process Record shall output the following products:

a. Screen displays of the search process list, to the standard output device.

b. The search process list, to floppy or hard disk.

c. The search process list, to printer.

3.1.6.3 Analysis TLSC

3.1.6.3.1 Purpose

The purpose of the top level Analysis component shall be to provide the capability to conduct analyses of the alphanumeric data stored in the Alphanumeric Data Base component. The Analysis component shall not have the capability to perform analysis of stored Graphics Data Base data. Statistical routines shall be defined externally to the Product 3 data base management system and shall be input to the Analysis component by use of the redirection operator. The user shall be provided with the capability to:

a. Transform quantitative information from its stored form to a user-selected display form.

b. Adjust data for variations in population and context.

c. Take correlations and time relationships between variables into account.

3.1.6.3.2 Objective

The objective of the top level Analysis component shall be to provide the capability for the user to apply statistical operations to manipulate and customize stored soldier characteristic alphanumeric data to derive customized design information.

3.1.6.3.3 General Description

The Analysis component shall contain the following sets of operations:

a. Descriptive Statistics

The design goal shall be to provide the descriptive statistics operations to permit the user to generate descriptive statistics that do not already reside in the Alphanumeric Data Base. However, the final number of lower level software components shall be determined during the detailed prototype design phase and shall be dictated by the results of detailed design tests with actual data.

b. Transformations

The transformation operations shall accomplish two distinct tasks which provide the user with the capability to:

(1) Change already-existing data base information into other forms, using transforms (logarithms, powers, and roots), or enable the combination of data in cases where more aggregate information may be desired.

(2) Enable the plotting of transformed data, to allow the user to test different transformations and compare the output graphs to determine which transformation offers the most utility.

c. Correlations/Predictions

The correlation/predictive operations shall provide the user with the capability to:

(1) Establish a simple or multiple correlation coefficient between two or more variables contained within a single data file, or across multiple data files to enable the user to establish customized relationships or dependencies that are not available within the stored data bases.

(2) Establish time series models to project characteristics or other data over periods of time not expressively covered by the data itself.

3.1.6.3.4 Inputs

Inputs to the Analysis component shall consist of entire alphanumeric data files or specified variables extracted from single files or across multiple files. The Analysis component shall have the capability to accept free-form and/or specifically formatted data. Dynamic memory shall be utilized to maximize the efficiency of the analytic operations.

3.1.6.3.5 Local Data

Local data structures shall be created to support the development of appropriate statistical results. The design goal shall be to implement these structures as dynamically as possible to assist in memory management. Efficient processing shall require the creation of matrices for a number of the calculations. The results of the internal calculations shall be transmitted from the Analysis component to the Design Aid Interface component to be displayed to the user for review and/or editing.

3.1.6.3.6 Sequencing

The Analysis component shall be entered only from the Design Aid Interface component and shall exit by user action to the Design Aid Interface component only. Access by the Design Aid Interface to the Analysis component shall be available at any time during a design aid session.

3.1.6.3.7 Processing

a. Algorithms

The Analysis component shall include standard algorithms for the computation of common statistical functions. The set of standard algorithms shall include, as a minimum, mean, standard deviation, variance, quantities, distributions, equation transformations, correlation coefficients, simple and multiple regressions, and moving average, autoregressive, and ARIMA time series components.

b. Special Control Features

Not Applicable.

c. Error Handling

The Analysis component may encounter errors in which the user calls for execution of specific statistical tests with inappropriate or an incorrect number of parameters. Such errors shall be handled as follows:

(1) Each statistical operation entry shall be accompanied by a prompt, describing the number and type of parameters that are expected by the operation. Further Help functions shall be available for each analytical operation, describing the purpose of the operation and the type of information that can be obtained through use of the operation. Help instruction shall include examples of sample data inputs and outputs.

(2) Given an error arising as a result of an attempt to execute a module without appropriate inputs, an error message shall be transmitted to the user, accompanied by appropriate help instructions.

(3) The Analysis component shall not have the capability to identify errors in semantics (e.g., errors of input content that are meaningless or errors of output content which are nonsensical). However, it shall be a design goal to provide an "intelligent" approach to the evaluation of Analysis operations.

3.1.6.3.8 Outputs

The output of the Analysis component shall be information generated as a result of one or more Analysis operations. This information shall consist of standard statistical results (e.g., mean, standard deviation, transformed data, and regression equations). The output shall be automatically saved as temporary text files and appended to the Search Process Record list. The user shall have the capability to save one or more of the files as a permanent file. Permanent files may be added to the permanent alphanumeric data base as a data base update activity, using the Knowledge Acquisition Interface to place the file and draw the appropriate file links.

3.1.6.4 Knowledge Acquisition Interface Component

3.1.6.4.1 Purpose

The Knowledge Acquisition Interface shall provide the capability to manually and automatically update and modify the Product 3 Alphanumeric and Graphics Data Base contents. Manual update operations shall be performed on the Alphanumeric Data Base only. Automatic update operations shall be performed on both the Alphanumeric and Graphics Data Base. Within the constraints of both the manual and automatic entry mode, the Knowledge Acquisition Interface shall provide the capability to:

a. Search for and replace, modify, and/or delete discrete data elements of already-existing data.

b. Search for and add new data to the existing data structure.

c. Search for and add, modify, and/or delete existing data structures or elements of data structures.

d. Ensure permanent attachment of new files to the search taxonomy.

3.1.6.4.2 Objective

The objective of the Knowledge Acquisition Interface shall be as follows:

a. Permit a knowledgeable user to locate a particular element in the database and change it, within the constraints of the applicable data structure.

b. Permit a naive user to locate the proper area of the database in order to add new data in conformance with the data structures of like data already residing in the database.

3.1.6.4.3 General Description

Given appropriate user access and/or security identification, the Knowledge Acquisition Interface top level component shall provide the capability to enter changes to the Product 3 alphanumeric and graphics data bases via manual or automatic means The Knowledge Acquisition Interface shall accept, control, and confirm data base changes through:

a. Manual inputs from the system workstation keyboard. In the manual mode, the user shall be led through complete system decomposition and levels of functional abstractions to the exact point in the data base where the changes will occur. For all deletions of data, the user shall be requested to confirm the entered deletion instructions prior to execution by the Knowledge Acquisition Interface. For entry of new data and/or modification of new data, the Knowledge Acquisition Interface shall output for display to the user, the maximum field lengths for each identified data element. In all manual entry activities, the user shall have the capability to cancel inputs at any time prior to final confirmation and implementation of the changes and the user shall be provided with the capability to edit the proposed changes.

b. Compatible floppy disks and/or Bernoulli removable disks.

3.1.6.4.4 Inputs

The Knowledge Acquisition Interface shall accept the following types of inputs:

a. Text files to be associated with the alphanumeric data base.

b. Bit-mapped graphics files associated with the graphics data base.

3.1.6.4.5 Local Data

Knowledge Acquisition Interface local data shall be generated for creation of the directed acyclic graph structure required to place, modify, or delete data

items or files, including adjustment of changed files, within the Alphanumeric or Graphics Data Base components.

3.1.6.4.6 Sequencing

a. For purposes of changing the Product 3 data bases, manual entry user-system interface commands shall flow to and from the Design Aid Interface component and the Knowledge Acquisition Interface component only.

b. For purposes of controlling the changes to the system data bases, information and instructions shall flow to and from the Knowledge Acquisition Interface to the Alphanumeric Data Base and/or the Graphics Data Base.

3.1.6.4.7 Processing

a. Algorithms

Not applicable.

b. Special Control Features

Not applicable.

c. Error Handling

Three types of errors may occur within the Knowledge Acquisition Interface component:

(1) Errors that occur due to lack of mass storage capability. Upon confirmation of data base change activities but prior to the actual accomplishment of the updating activity, the Knowledge Acquisition Interface component shall size an input and compare its size with the amount of mass storage remaining. When the size of the input is greater than the largest fragment of storage remaining, the component shall first attempt to coalesce files to attempt to create the required storage space. If the required storage space cannot be achieved, the Knowledge Acquisition Interface component shall provide the user with a message signifying that there is insufficient storage. These or other files may then be transferred to a Bernoulli disk or floppy disk.

(2) Errors that occur when incorrect data is entered into a file. To reduce the probability of incorrect entry, the Knowledge Acquisition Interface shall have the capability of:

(a) Echoing inputs back to the user, and

(b) Requiring positive acknowledgement by the user before making the requested changes.

(3) Errors that occur when an incorrect pathway to a new file has been constructed. The component shall provide the user with as clear a path choice as possible when placing a new file through the use of the same taxonomy as that used in the design search.

3.1.6.4.8 Outputs

The top level Knowledge Acquisition Interface component shall output to the default mass storage device all file modifications and add new files as specified by the user. These outputs shall include text modifications and new text files into the alphanumeric data base, and new graphics files into the graphics data base. All changes and additions made to either data base shall result in confirmations being returned through the Knowledge Acquisition Interface to the user.

3.1.6.5 Training/Help TLSC

3.1.6.5.1 Purpose

The Training/Help functions shall ensure that the user has the information available to conduct a design aid session efficiently and with a minimum of errors. The user shall be able to gain an understanding of the functionality of the system and be offered a clear and unambiguous path at each step in the search process. Help shall be available at every point in the process that gives the user an option in selecting the next search space. In addition, there shall be enough information provided to the individual supporting and maintaining the system so that all errors and system modifications can be competently addressed.

3.1.6.5.2 Objective

3.1.6.5.2.1 Training Objectives

Training objectives for the top level Training and Help software component shall include providing user personnel with the capability to obtain a comprehensive system overview; to instruct new users on how to conduct a design aid session; and instruct users how to request help instructions beyond that help which is automatically presented in the conduct of system operations.

3.1.6.5.2.2 Help Objectives

Help objectives for the help function shall be to enable the user to conduct a design aid session efficiently and with a minimum of errors. The help option shall provide the user with the capability to obtain information at all junctures

in the design aid session where one or more options shall be selected by the user to prescribe the next design aid session process , and where user-inputs cause system errors. In addition, the help function will provide assistance, via help screens, when performing local system data base updates and/or local system software maintenance activities.

3.1.6.5.3 General Description

3.1.6.5.3.1 Training

There shall be two training options available for user selection:

a. A system overview option that shall present a comprehensive overview of the system, including a description of the intended purpose of Product 3, to give the user a conceptual understanding of the organization of the Product 3 system.

b. An on-line training capability to enable naive or inexperienced design session aid user personnel, including user personnel with little or no computer experience, to understand how to use Product 3 to obtain system design specification requirements. A comprehensive on-line tutorial "sample" design session aid training program shall be provided, in which user personnel, immediately upon turning the system on, shall have the option to select a sample design aid session tutorial. The user shall be led through a hypothetical design scenario and, drawing upon actual data base files, be taught how to search through the data base for relevant design information; how to browse, edit, and save *Search Process Record files*; and how to print out hard copies of the results. The tutorial shall assist the user in gaining an understanding of the functionality of the system and how to select clear and unambiguous paths at each step in a design aid session. At no time during the tutorial presentation shall the user be required to provide technical inputs.

3.1.6.5.3.2 Help

On-line help shall be available for each display screen at which the user has an option as to the direction to proceed. This shall occur whenever menus are displayed, giving the user a list of possible alternatives to select. Help shall not be available on screens displaying alphanumeric or graphics design information. Two types of help shall be available:

a. A short text that shall be displayed whenever the user selects a menu options and/or where a screen requests a user to enter a particular item of information in order to proceed. The text shall be displayed at the bottom of the screen and shall give the user a brief description of the option or legal values that can be selected. This assistance shall act as a quick reference guide and memory

jogger to the experienced user needing a reminder of the functionality of the system and/or to an inexperienced user requiring information on system data entry requirements. The training review shall be available at system initialization or upon termination of the design aid session.

b. Through the activation of a keyboard function key, the presentation of help screens which shall provide a more complete description of the choices available at that point in the search or where a screen requests a user to enter a particular item of information in order to proceed. These descriptions may take up to the entire full screen, and shall be comprehensive enough to instruct the inexperienced user. Each selection available at that point in the search shall be described in detail, giving both the purpose of the selection and the direction it will lead the user in the search. Exiting from the help screen shall return the user back to the original screen display. Help shall be available at any point in a design aid session.

3.1.6.5.4 Inputs

Inputs required for the Training/Help component shall be those which select the training/help menu item and/or the activation of the terminal keyboard Help function key.

3.1.6.5.5 Local Data

Training/Help local data shall consist of textual data making up the content of the help messages.

3.1.6.5.6 Sequencing

The Training/Help top level software component shall be called from the Design Aid Interface component only. The training component shall, in turn, call a sequence of other system components, as required, to conduct the sample design aid session. Control shall remain within the Design Aid Interface when help functions are called.

3.1.6.5.7 Processing

a. Algorithms

No algorithms shall be required to implement the Help facility. The training module running a sample design aid session shall be implemented with an algorithm to call the Design Aid Interface component internally and to proceed through the top level software components as a real design search would.

b. Special Control Features

Not Applicable.

c. Error Handling

Not Applicable.

3.1.6.5.8 Outputs

Outputs to the help facility shall be textual messages directed to the standard output device. Outputs to the training facility shall be textual messages and screen displays to the standard output device making up a sample design search. The user shall have the option of directing this search to the printer.

3.1.6.6 Alphanumeric Data Base TLSC

3.1.6.6.1 Purpose

The Alphanumeric Data Base shall accept, store, process and control Alphanumeric Data Base information to provide data that is of value to an Army weapon or support system designer. These data shall be organized in files based on a logical taxonomy enabling access of the data from system descriptions and requirements provided by the user. The design goal shall be to organize and present the data in a way that will assist in to the accomplishment of the objectives of the system designer.

3.1.6.6.2 Objective

The objective of the Alphanumeric Data Base shall be to enable presentation of alphanumeric design data in the form of text, tabular, and statistical form.

3.1.6.6.3 General Description

The Alphanumeric Data Base component shall be composed of ASCII-formatted text files. These files shall be accessed through the Design Aid Interface by the design search process, and shall be displayed to the user as required. The exact files and individual data items to be displayed to the user shall be determined by the search method contained in the Design Aid Interface component.

3.1.6.6.4 Inputs

The Alphanumeric Data Base component shall receive inputs from the Design Aid Interface component and the Knowledge Acquisition Interface component. From the Design Aid Interface it shall receive a pointer to a particular file to be displayed to the user. From the Knowledge Acquisition Interface it shall receive new text files to be included as a part of the data base.

3.1.6.6.5 Local Data

Not Applicable.

3.1.6.6.6 Sequencing

The Alphanumeric Data Base component shall consist of passive text files. Therefore, it shall not execute *per se*, but shall be accessed only in response to requests from other components (e.g; the Design Aid Interface and the Knowledge Acquisition Interface components). These accesses shall be controlled by the search process from the Design Aid Interface, and by the update process from the Knowledge Acquisition Interface.

3.1.6.6.7 Processing

a. Algorithms

   Data files shall be organized and accessed using the REVELATION LHASH algorithm.

b. Special Control Features

   Not Applicable.

c. Error Handling

   An error may occur when the Design Aid Interface component requests access to a nonexistent file; that is, requests for files inadvertently removed from the data base by the user or lost because of disk error. When a request is made for a non-existent file, an error message shall be transmitted to the user, stating the probable cause of the error and accompanying help instructions.

3.1.6.6.8 Outputs

Outputs from the Alphanumeric Data Base component shall be extracts from text data files, which are passed to the Design Aid Interface and presented to the user. Data from these Alphanumeric Data Base files may also be passed to the Analysis component, where they are used as input to one or more of the Analysis modules.

3.1.6.7 Graphics Data BaseTLSC

3.1.6.7.1 Purpose

The Graphics Data Base component shall define the structure, format, and content of all terminal data screens displaying graphical information. These screen displays shall exist in data base files separate from the Alphanumeric. Data

Base, and shall represent static information that may be combined with text files to produce an information display appropriate to the Army system being designed.

3.1.6.7.2 Objective

The top level Graphics Data Base software component shall be designed to accept, control, process and transmit bit-mapped graphic images.

3.1.6.7.3 General Description

The Graphics Data Base component shall contain only bit-mapped graphical images placed in data files on the MANPRINT Product 3 system's mass storage device. It shall not include intermediate screen displays in any of the directly user-accessible software components, or any of the graphical output produced as a result of the execution of any of the modules in the Analysis component. These graphics shall include drawings, complete with measurements, of relevant human engineering information; graphs, usually depicting performance parameters, relationships, and rates; and charts displaying pertinent summaries of information. The Graphic Data Base files shall be entered into the Product 3 graphics data base by scanning and digitizing already-existing graphics, by redrawing existing graphics or drawing new graphics based on information available in source documents, or by generating EGA-based graphics from textual information already within the data base.

3.1.6.7.4 Inputs

The Graphics Data Base component shall receive inputs from the Design Aid Interface component and the Knowledge Acquisition Interface component and shall receive data file requests from the Analysis Component. From the Design Aid Interface it shall receive a pointer to a particular file to be displayed to the user. From the Knowledge Acquisition Interface it shall receive new bit-mapped graphics files to be included as a part of the data base.

3.1.6.7.5 Local Data

Not Applicable.

3.1.6.7.6 Sequencing

The Graphics Data Base component shall consist of passive graphics files. Therefore, it shall not execute *per se*, but shall be accessed only in response to requests from other components, e.g., the Design Aid Interface and the Knowledge Acquisition Interface components. These accesses shall be controlled by the search process from the Design Aid Interface, and by the update process from the Knowledge Acquisition Interface.

3.1.6.7.7 Processing

a. Algorithms

Data files shall be organized and accessed using the REVELATION LHASH algorithm.

b. Special Control Features

Not Applicable.

c. Error Handling

An error may occur when the Design Aid Interface component requests access to a nonexistent file; that is, requests for files inadvertently removed from the data base by the user or lost because of disk error. When a request is made for a non-existent file, an error message shall be transmitted to the user, stating the probable cause of the error and accompanying help instructions.

3.1.6.7.8 Outputs

Outputs from the Graphics Data Base component shall be bit-mapped graphics files, which are passed to the Design Aid Interface and presented to the user.

3.1.7 Adaptation Data

All sites with the hardware/software components specified in the ARI System Integration Guidelines (Appendix I) shall be able to accept the MANPRINT Product 3 software system without modification. Those sites without a removable hard disk capability shall be required to download Product 3 from floppy disks into a fixed hard disk of at least 20 megabytes.

3.1.8 System Maintenance

System maintenance shall consist of two separate functions:

a. Updating information contained in the alphanumeric and/or graphics data bases.

b. Maintaining Product 3 user accounts and access privileges.

3.1.8.1 Data Base Maintenance

All data base maintenance shall occur from the Knowledge Acquisition Interface top level software component. Access to this component shall be by authorized personnel only. Access shall be managed in accordance with the procedures in Section 3.1.8.2. The system shall offer the option of either

manual or automatic updating for the alphanumeric data base. The graphics data base shall be updated automatically only. Automatic update shall occur from a mass storage device (e.g., floppy or Bernoulli hard disk). Updating activities shall include the following:

a. Editing existing alphanumeric files.

b. Adding or replacing entire alphanumeric or graphic files.

c. Adding or modifying taxonomic pathways accessing the files.

d. Preparation of files in the DIF format for file transfer.

3.1.8.2 Account/Access Maintenance

Account/access maintenance shall be a menu item, accessible by authorized personnel only. Selection of the maintenance menu option shall permit the following operations:

a. Add account number/password.

   Permits the addition of an account number and password for a new Product 3 user.

b. Delete account number/password.

   Permits the removal of an account number and password for a noncurrent user.

c. Change password.

   Permits the modification of a password for a current user.

d. Add privileges.

   Permits the addition of system access privileges to the account of a current user. Privileges include: conduct design search, write to disk, modify data base, and access system maintenance.

e. Delete Privileges.

   Permits the deletion of system access privileges to the account of a current user. Privileges include: conduct design search, write to disk, modify data base, and access system maintenance.

3.2 Detailed Design Requirements

3.2.1 Interface Design

The system interfaces between the Product 3 top level software components shall be as configured and illustrated in Figure 3-2. The major interfaces shall include those associated with the Design Aid Interface, the Search Process Record, the Analysis, and the Knowledge Acquisition Interface components.

3.2.1.1 Design Aid Interface

The major interfaces of the Design Aid Interface shall include the interfaces with the Search Process Record, the Analysis, the Knowledge Acquisition Interface, Training and Help, the Alphanumeric Data Base and the Graphics Data Base components.

3.2.1.1.1 Design Aid Interface/Search Process Record

Transfer of control shall be exchanged between the Design Aid Interface component and the Search Process Record component, as required by the internal design aid interface software processes. Transfer of control shall occur when the Search Process Record is appending screen displays and data base files generated by the design search to a directed acyclic list maintained by the Search Process Record. The files appended to this list shall be either text and/or bit-mapped graphic files, and shall include appended screen displays generated by the Design Aid Interface component. All other data shall flow from the Design Aid Interface to the Search Process Record component only. Copies of the data files shall be used, rather than pointers to the actual files, to enable editing, saving, and printing of the record.

3.2.1.1.2 Design Aid Interface/Analysis

Direction of data flow other than that required for control transfer shall be from the Design Aid Interface component to the Analysis component only. The text data files selected to be input into a particular Analysis module shall be transferred into that module through the use of the MS DOS redirection ("piping") operation. The Analysis component shall have its own menu- and output-driven user interface and therefore there shall be no requirement to. return data from the Analysis component to the Design Aid Interface component, other than that required to return control to the Design Aid Interface. The Design Aid Interface component shall have the capability to enable transfer of control between the Design Aid Interface component and the Analysis component when the analysis component receives instructions to accomplish statistical evaluations. Statistical evaluation instructions shall include:

a. Preparation of descriptive statistics not found in the data files themselves;

b. Transformation of data into forms that can be saved as separate files and input into other analysis modules or that can be output directly with greater meaning and utility to the design process; and

c. Preparation of correlations or other adjustments, such as time series that can be used enhance the predictive value of the data.

3.2.1.1.3 Design Aid Interface/Knowledge Acquisition

Direction of data flow other than that required for control transfer shall be from the Knowledge Acquisition Interface component to the Design Aid Interface Component only. Control transfer shall enable the user to enter new or modified data either manually or from a transportable storage medium into the Product 3 data bases. Given entry of new data files, new links shall be constructed by passing the pathways to the data, which will then connect the taxonomy used by the Design Aid Interface to access the new data files. These pathways shall be either drawn by the user, with assistance by the interface, in the case of manual update, or by an already existing path, in the case of transportable storage medium update.

3.2.1.1.4 Design Aid Interface/Training and Help

The Training/Help component shall consist of two lower level software components: training and help. Control transfer data shall be exchanged between the training and the Design Aid Interface components. All other data shall be in both directions between these components. Following Training component control instructions, the Design Aid Interface shall conduct a sample design aid search and return the results back to the training module, which shall present them, without modification, to the user. Control instructions shall pass from the Training module to the design Aid Interface, which in return shall pass the results of the design aid search as defined by the control instructions back to the Training module. Flow of data between the lower level help components shall be bi-directional. The Help module shall be fully integrated within the Design Aid Interface. The flow of data between the two shall be bi-directional. From the Design Aid Interface, Help shall be obtained through brief prompts presented to the user upon the selection of a menu option or by data entry option at any point in the Design Aid Interface. For brief prompts the transfer between the components shall be automatic. Use of the data entry option shall be by selection of the appropriate function key. Each screen display in the Design Aid Interface shall have an accompanying Help display. The user, by activating the Help function for a particular screen display, shall cause the information necessary for the selection of the accompanying Help display to be passed to the appropriate Help display. Upon completion of review, control shall be

passed back to the original Design Aid Interface display, although no information will have passed across the interface.

3.2.1.1.5 Design Aid Interface/Alphanumeric Data Base

The flow of data between these two components shall be bi-directional. Variables leading to the selection of the appropriate alphanumeric data file shall pass from the Design Aid Interface component to the designated file in the Alphanumeric Data Base component. The selected Alphanumeric Data Base file data, without modification, shall be passed to the Design Aid Interface component, for display to the user.

3.2.1.1.6 Design Aid Interface/Graphics Data Base

The flow of data between these two components shall be bi-directional. Variables leading to the selection of the appropriate graphics data file shall pass from the Design Aid Interface component to the designated file in the Graphics Data Base component. The selected Graphics Data Base file data, without modification, shall be passed to the Design Aid Interface component, for display to the user.

3.2.1.2 Search Process Record Interfaces

The Search Process Record component interfaces with two other top level software components, the Alphanumeric Data Base and the Graphics Data Base.

3.2.1.2.1 Search Process Record/Alphanumeric Data Base

Data shall flow from the Alphanumeric Data Base component to the Search Process Record component. The data transferred shall take the form of text files which are extracts of identical files found in the Alphanumeric Data Base.

3.2.1.2.2 Search Process Record/Graphics Data Base

Data shall flow from the Graphics Data Base to the Search Process Record component. The data transferred shall take the form of bit-mapped graphics files which are copies of identical files found in the Graphics Data Base.

3.2.1.3 Analysis/Alphanumeric Data Base

Data shall flow from the Alphanumeric Data Base to the applicable lower level analysis software component only and shall consist of text files of data to be entered directly into the selected Analysis component.

3.2.1.4 Knowledge Acquisition Interface

The Knowledge Acquisition Interfaces shall include interfaces with the Alphanumeric Data Base and the Graphics Data Base.

3.2.1.4.1 Knowledge Acquisition Interface/Alphanumeric Data Base

Data shall flow bi-directionally between the Knowledge Acquisition Interface and the Alphanumeric Data Base. The information transmitted by the Knowledge Acquisition Interface shall include individual ASCII numeric values that are added to individual data files and/or the addition or deletion of entire ASCII text files. The individual numeric values shall be intergers or floating point numeric values, which can be appended to the individual data base files. The numeric values, upon being appended, shall be capable of being edited. Complete files shall be passed as an ASCII stream from the Knowledge Acquisition Interface to the Alphanumeric Data Base in the automatic update mode only. Data from the Alphanumeric Data Base to the Knowledge Acquisition Interface shall consist of process completion and acknowledgement data.

3.2.1.4.2 Knowledge Acquisition Interface/Graphics Data Base

Data flow between the Knowledge Acquisition Interface and Graphics Data Base shall be possible in the automatic data base update mode only. The Knowledge Acquisition Interface shall act as a conduit between a floppy disk containing update files and the Graphics Data Base, taking files fromthe disk, placing them into the data base, and relinking the pathways from the Design Aid Interface to the new files. These fields shall be bit-mapped for improved resolution and compressed in order to save storage space, and shall be passed as a bit stream of data words from the Knowledge Acquisition Interface to the Graphics Data Base.

3.2.2 Global Data

Global data in Product 3 shall consist of the text and graphic data files that comprise the Alphanumeric and Graphics Data Bases, respectively. Alphanumeric and Graphics Data Base files shall not be directly available to the user, but shall be accessible for display through the Design Aid Interface, Analysis, and Knowledge Acquisition Interface components. Entire text or data files, portions of text files, or combinations of text and data files shall be passed through these user-accessible components and displayed to the user. From within the Design Aid Interface and Analysis components, these displays shall become a part of a design search. From within the Knowledge Acquisition Interface, this display shall assist a user in updating data files. Search Process Record lists shall consist of copies of screen displays and data that are created and initialized in the Search Process Record TLSC but for efficiency shall be maintained in the Design Aid Interface and Analysis

TLSCs, where the actual screen displays are generated. Search Process Record lists shall be passed between components as required by pointer address to the head of the list. Individual lists shall be composed of nodes that are connected by pointers to the address of the next node. Each node shall consist of the data portion, which contains the data or screen display, and the address portion, which contains the pointer to the next node.

3.2.3 Detailed Design

The Product 3 software system shall be based upon a relational data base of significant soldier characteristics. The Product 3 data base shall be divided into two top level software components, consisting of the Alphanumeric Data Base and the Graphics Data Base components. The other five top level software components shall interface with the data bases to assist the user in data reduction, creation of editable files, statistical data analysis, data base maintenance, training, and help. The data base shall be designed in accordance with the requirements of Appendix IV, Data Base Structure and User Presentation, and Appendix V, Data Base Design Specification. The breakdown of top level components into detailed components shall be as diagrammed in Figure 3-3. Decision pathways available to the Product 3 user shall be as diagrammed in Figures 3-4 (levels one to three), 3-5 (system operations to level five), and 3-6 (system maintenance to level five).

3.2.3.1 Design Aid Interface TLSC

The Design Aid Interface component shall include all intermediate user interfaces and functions not explicitly reserved for one of the other top level software components. It shall be implemented in the Revelation Data Base Management System. Design Aid Interface inputs and outputs shall be diagrammed in Figure 3-7. It shall be divided into two lower level software components (LLSCs):

a. Interface LLSC

   The Interface LLSC shall maintain and control all necessary interfaces with the user, and shall be responsible for transferring control to the other top level software components, as required. The Interface LLSC shall be responsible for all interfaces between the Design Aid Interface and other user-accessible components.

b. Data Base Access LLSC

   The Data Base Access LLSC shall provide all routines necessary for the access of data base information as specified by the input instructions. All interfaces between the Design Aid Interface and the two data base components shall be through the Data Base Access LLSC only.

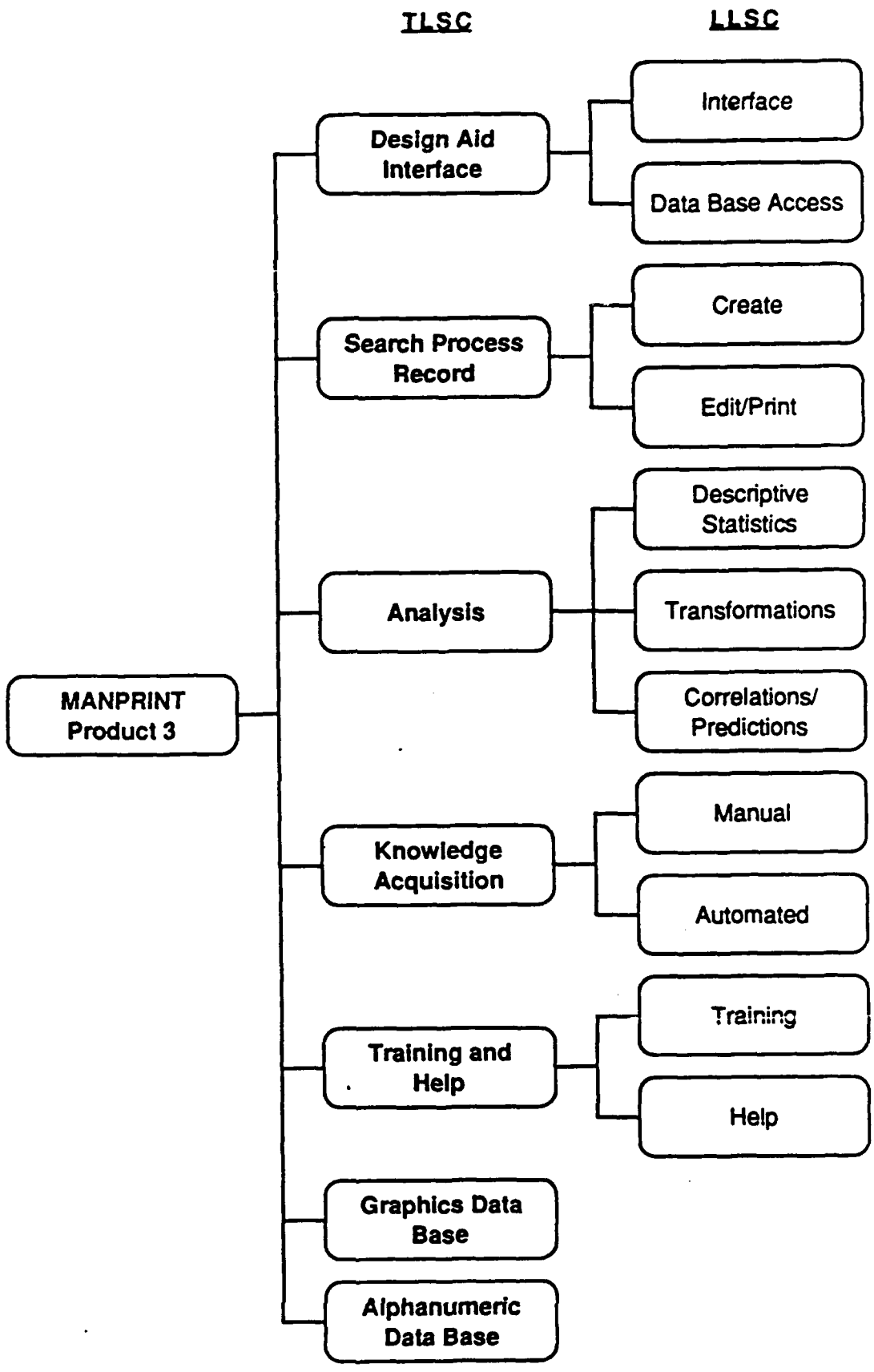

Figure 3-3. Component Breakdown

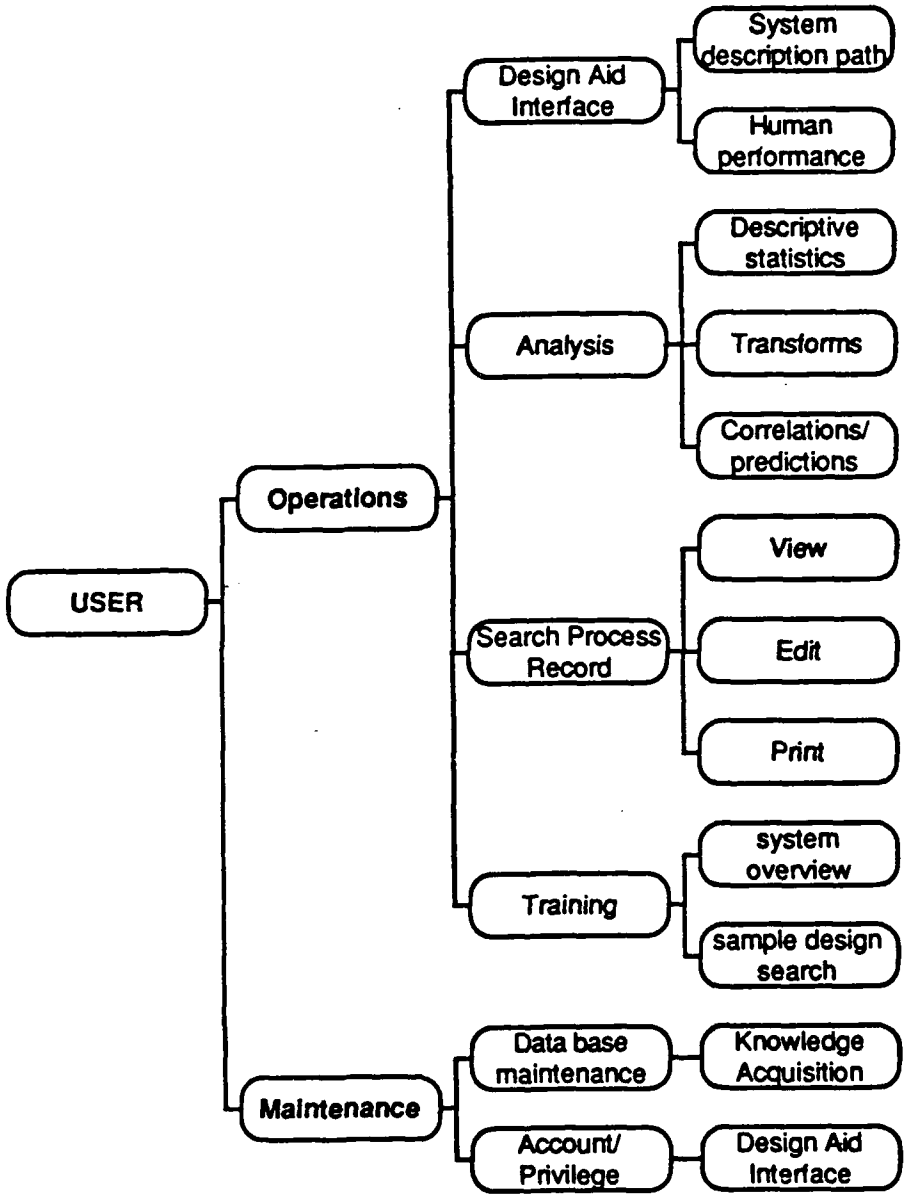

Figure 3-4. High Level Decision Pathways

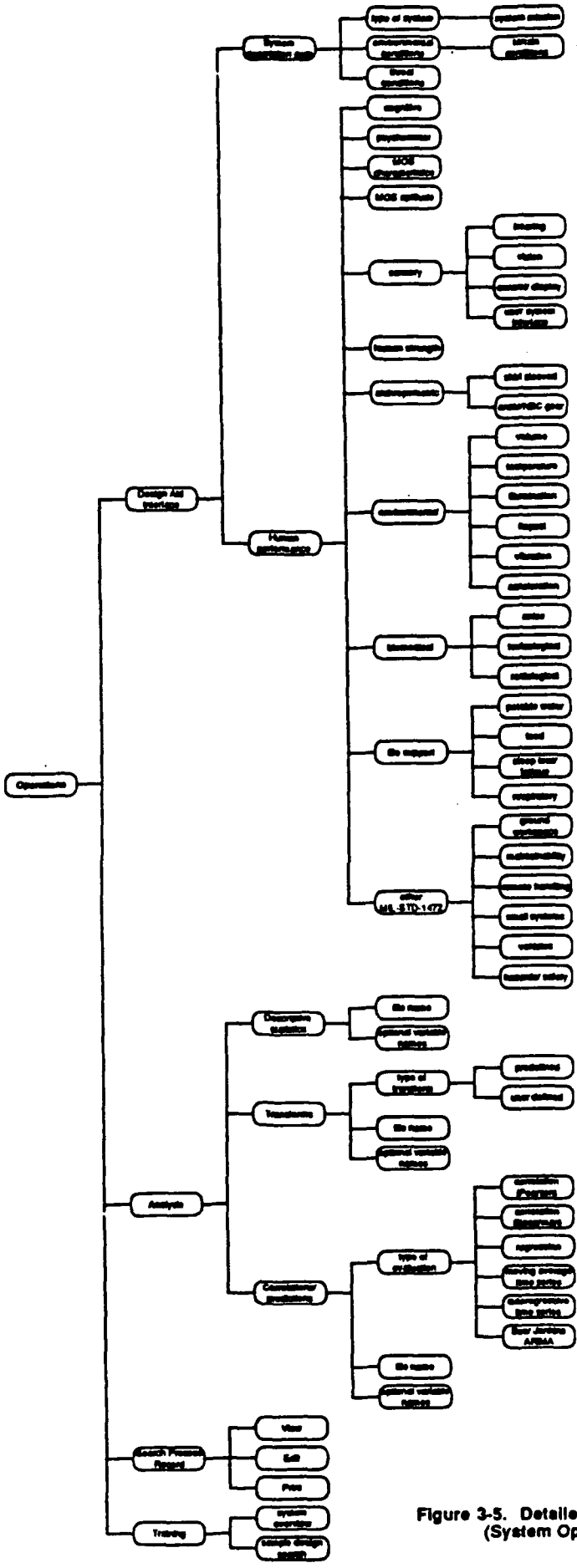

Figure 3-5. Detailed Decision Pathways (System Operations)

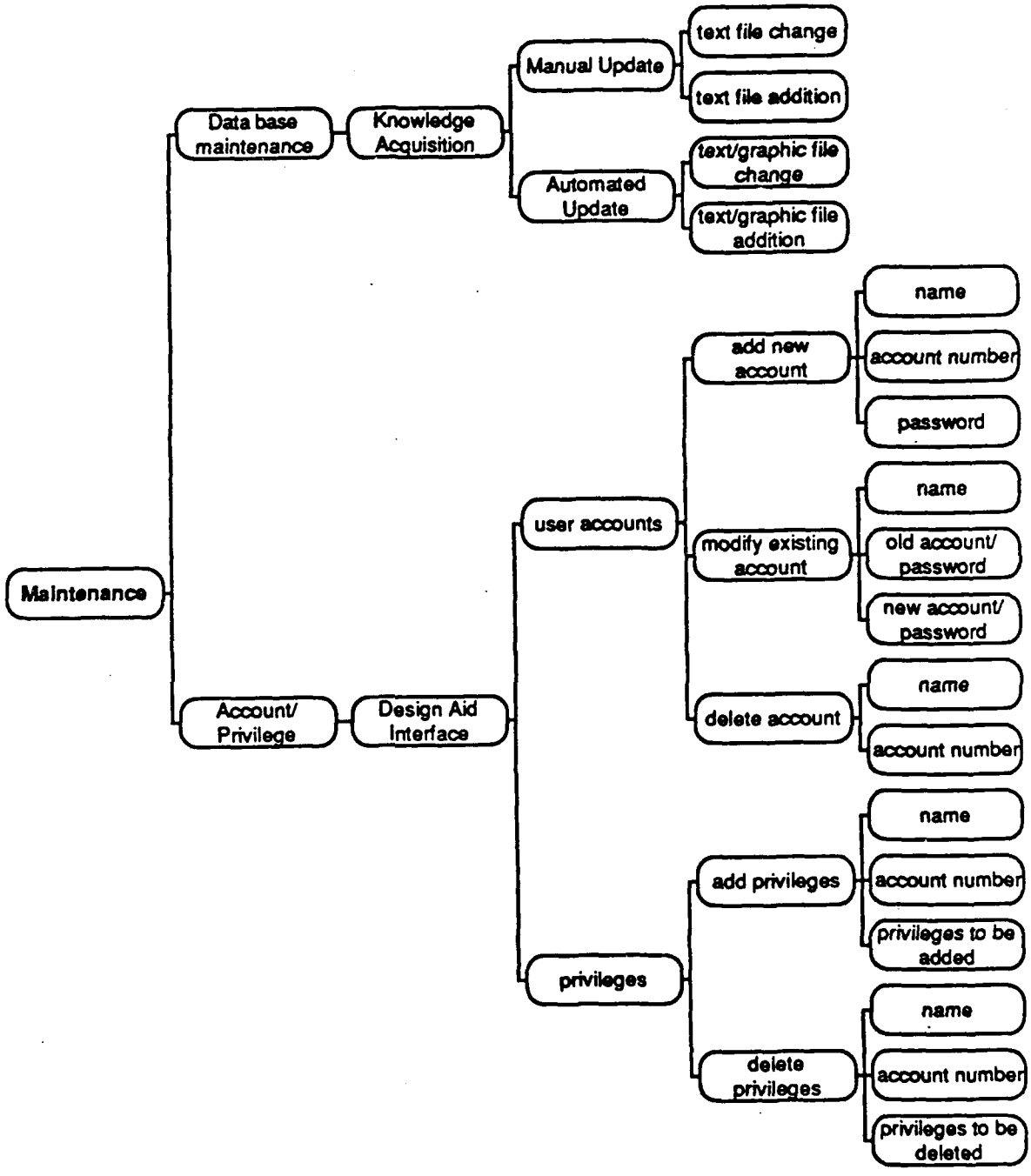

Figure 3-6. Detailed Decision Pathways (System Maintenance)

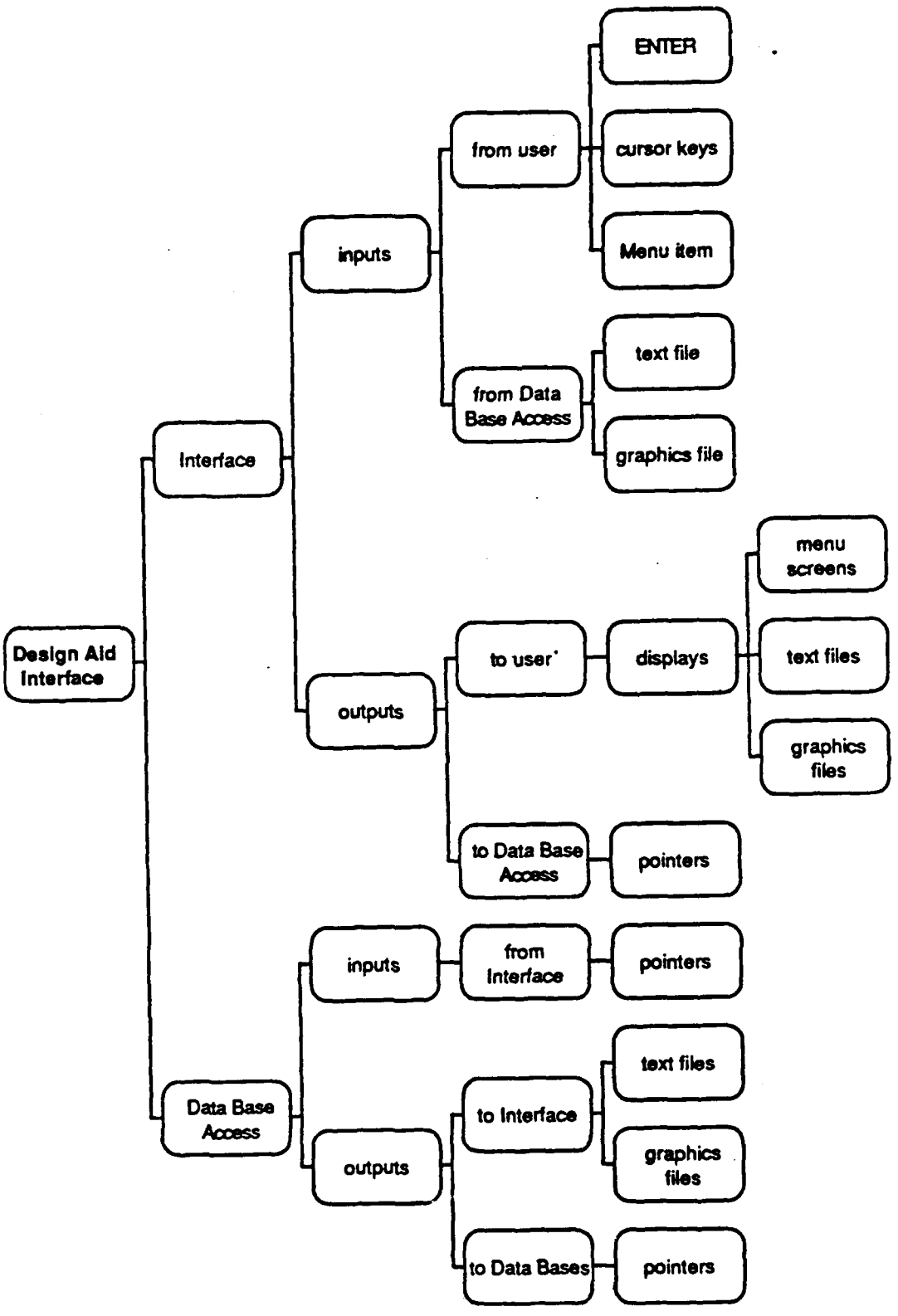

Figure 3-7. Design Aid Interface Input/Output Chart

3.2.3.1.1 Design Aid Interface Requirements Allocation

The requirements of the Design Aid Interface component are divided into three types of operations and allocated to lower level software components; two of the operations are assigned to one lower level software component for purposes of grouping commonality of functions. The allocations are as follows:

a. User Interaction

   User interaction shall consist of all screen displays found within the Design Aid Interface component, along with their subordinate elements, including titles and menus. All user interaction operations shall be allocated to a lower level software component designated as the Interface LLSC.

b. User-Accessible Component Interaction

   User-accessible component interaction shall include those functions necessary for the transfer of control from the Design Aid Interface component to the Analysis, Search Process Record, Knowledge Acquisition Interface, and Training/Help components. All user-accessible component interactions shall be allocated to the Interface LLSC.

c. Data Base Interaction

   Data base interaction shall include the process of locating the appropriate data base files and displaying them to the user, the capability to interact with the user interaction function, to control the display of Alphanumeric and Graphic Data Base information, the taxonomic structure necessary to translate the user-provided information into a pointer to the appropriate data bases, the ability to access these data bases, and the ability to display these data bases to the user. The data base interaction shall be allocated to the Data Base Access LLSC. All access from the Design Aid Interface to the Alphanumeric and Graphics Data Bases shall occur through the Data Base Access LLSC.

3.2.3.1.2 Interface LLSC

The Interface LLSC shall provide an interface with both the user and the other user-accessible software components.

a. Inputs

System control shall always default to the Interface LLSC. Inputs shall be taken from the keyboard using function keys and arrow keys. Inputs shall be processed through the BIOS as interrupts to the Product 3 system, initiating transfers of control to the appropriate LLSC. Other keyboard operations may be disabled in this LLSC, during control default conditions.

Input	Purpose	Method	Source
ENTER	Execute instructions	Direct Input	User
Arrows	Move cursor	Direct Input	User
Menu Item	Help	Direct Input	User
Text File	Display	Pointer Address	Data Base Access LLSC
Graphics File	Display	Pointer Address	Data Base Access LLSC

b. Local Data

Local data shall consist of intermediate screen displays used for directing the user through the design aid process.

c. Processing

(1) Control

The Interface LLSC shall receive system control upon startup and system initialization. Control shall always be transferred upon given user inputs to other user-accessible components. Control shall transfer automatically to the Data Base Access LLSC once the user has selected a design search pattern to a depth sufficient to provide a pointer into the appropriate data base file. Control shall then be transferred back to the Interface LLSC for display of the file.

(2) Algorithms

Standard data structures and manipulation procedures shall be required to implement this LLSC. The data structures, readily available from commercial sources, shall take user inputs, and select the appropriate display from a tree structure. The displays which are accessed via pointers shall then be mapped into the standard output device.

(3) Special Control Features

Not Applicable.

(4) Error Handling

An Interface LLSC user-initiated error may occur if the user selects one of the keys not associated with a legitimate system operation, a prompt shall appear at the bottom of the screen, indicating the operations that are available from that point and the actions necessary to implement those operations. Other Interface LLSC errors may occur if the component control to which control is transferred does not exist on the system. In such cases, the error shall cause an output to the user, indicating the source of the error and providing accompanying help instructions.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Interface LLSC shall be responsible for appending the screen displays to the Search Process Record. The Interface LLSC shall receive a pointer from the Create LLSC in the Search Process Record component to the Search Process Record linked list at system initialization. The only function that shall be performed by the Interface LLSC thereafter shall be to append each screen display to the linked list.

e. Limitations

Not Applicable

f. Outputs

The Interface LLSC shall have two types of outputs:

(1) text files that make up the user interface, defined as direct output to the standard output device; and

(2) pointers, defined by user selection of system characteristics, that are passed to the Data Base Access LLSC for selection of the appropriate data file. These pointers shall be passed by pointer address from the Interface LLSC to the Data Base Access LLSC.

Output	Purpose	Method	Destination
displays	user interface	direct output	user
pointer	select data file	pointer address	Data Base Access LLSC

3.2.3.1.3 Data Base Access LLSC

The Data Base Access LLSC shall select the appropriate data file and pass it back to the Interface LLSC for display.

a. Inputs

The Data Base Access LLSC shall receive a pointer from the Interface LLSC. The pointer shall be passed by pointer address from the Interface LLSC to the Data Base Access LLSC.

Input	Purpose	Method	Source
pointer	select data file	pointer address	Interface LLSC

b. Local Data

No local data shall be required to execute the Data Base Access LLSC. Pointers shall be passed from the Interface LLSC and data files from the Alphanumeric or Graphics Data Bases shall be returned for display.

c. Processing

(1) Control

The Data Base Access LLSC shall receive system control automatically from the Interface LLSC once the user has indicated the desired design search pattern through the user interfaces sufficiently to provide a pointer into the appropriate data base file. When the Data Base Access LLSC has found the correct file, control shall then be transferred back to the Interface LLSC for display of the file.

(2) Algorithms

Not Applicable.

(3) Special Control Features

Not Applicable.

(4) Error Handling

Data Base Access LLSC errors may occur if the data file required by the user does not exist on the system. In such cases, the error shall cause an output to the user indicating the source of the error and providing accompanying help instructions.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Data Base Access LLSC is self-contained and uses no elements from other components, except for inputs as noted above.

e. Limitations

Not Applicable.

f. Outputs

The Data Base Access LLSC shall have two types of outputs:

(1) text files that are extracted from the Alphanumeric Data Base, and sent through to the Interface LLSC for direct output to the standard output device; and

(2) bit-mapped graphics files that are extracted from the Graphics Data Base and sent through to the Interface LLSC for direct output to the standard output device.

Output	Purpose	Method	Destination
text files	return data file	pointer address	Interface LLSC
graphics files	return data file	pointer address	Interface LLSC
pointer	access data file	pointer address	Alphanumeric/ Graphic Data Bases

3.2.3.2 Search Process Record TLSC

The Search Process Record shall create, maintain, store, and prepare for output a list of the data files and displays viewed during the course of a design aid session search. The functions performed by the Search Process Record shall include creating a search record, saving a search record and returning to it later, editing a search record, and printing a search record. The Search Process Record component shall be divided into two LLSCs, the Create component and the Edit/Print component. The Create LLSC shall include the data structures and algorithms necessary to create and append to the list of displays. The Edit/Print LLSC shall permit the user to manipulate an already-existing search list and to save and/or print out the appended results of a search process. The Search Process Record inputs and outputs shall be as diagrammed in Figure 3-8.

3.2.3.2.1 Search Process Record Requirements Allocation

The allocation of the creating function shall be considered separate from the other Search Process Record functions, to permit records to be globally available to all user-accessible components and allow updating to occur. Therefore, the creating and maintaining functions shall be allocated to a lower level software component designated as the Create LLSC. The functions of saving and returning, editing, and printing are components of a standard text editor and shall be allocated to a lower level software component designated as the Edit/Print LLSC.

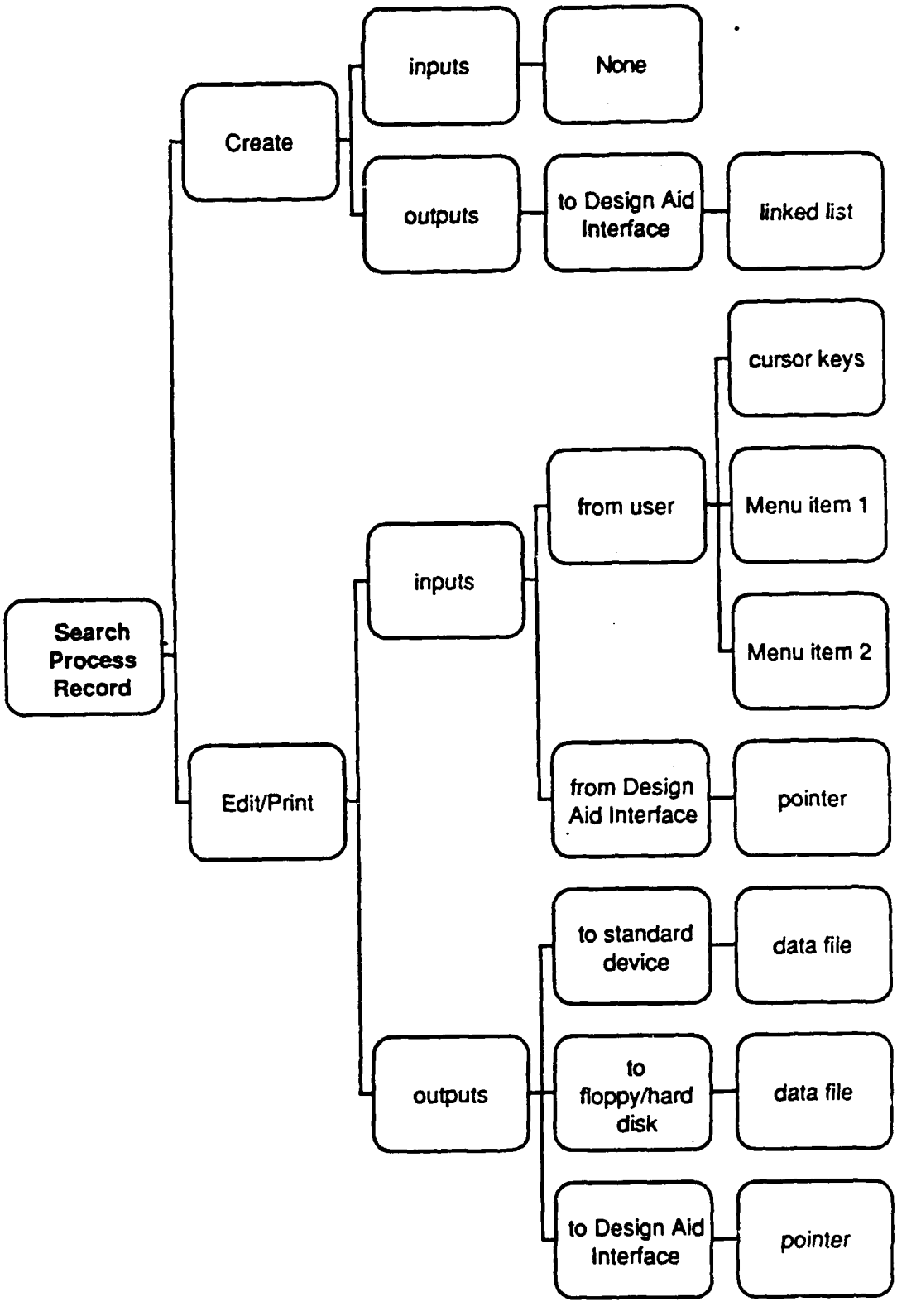

Figure 3-8. Search Process Record Input/Output Chart

3.2.3.2.2 Create LLSC

The Create LLSC shall generate the data structures necessary to build the Search Process Record. These actions shall occur automatically at system initialization. Once the data structures are created, each screen shall be appended to the linked list structure from the Design Aid Interface component, to eliminate the need for an additional transfer of control back to the Search Process Record component to accomplish this function. The linked list shall then be passed back to the Design Aid Interface at system initialization, where it shall be maintained by the Design Aid Interface component until user inputs request a transfer back to the Search Process Record.

a. Inputs

Not Applicable.

b. Local Data
Those variables necessary to create the list data structure comprise the Create LLSC local data.

c. Processing

(1) Control

The Create LLSC shall receive control automatically as a part of Product 3 system initialization at startup. After creating and initialization of the Create LLSC's own data structures, control shall automatically return to the Design Aid Interface component.

(2) Algorithms

Algorithms utilized in the Create LLSC, consist of those variables necessary to create the list data structure.

(3) Special Control Features

Not Applicable.

(4) Error Handling

A Create LLSC external error may occur when a file necessary to execute the Create function is not available at startup. The system will not boot, and an error message shall be transmitted to the user, stating the reason for the error and providing accompanying help instructions.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

Not Applicable.

e. Limitations

Not Applicable.

f. Outputs

The Create LLSC shall provide the Design Aid Interface component with a linked list data structure onto which all screen displays are appended. This list shall be constructed with pointers to allocate memory dynamically, a feature that also permits the output to be passed out of the LLSC via a pointer address.

Output	Purpose	Method	Destination
pointer	pass linked list	pointer address	Interface LLSC

3.2.3.2.3 Edit/Print LLSC

The Edit/Print LLSC shall provide a text and screen edit capability for the Search Process Record and shall enable the user to direct the output of the Search Process to system accessible media. This capability shall permit the editing of a design search to the requirements necessitated by the design project and prepare the text and graphics for output.

a. Inputs

To enable edits of the Search Process Record, the record itself shall be passed into the Edit/Print LLSC. A pointer to the head of the list shall be passed as a parameter.

Input	Purpose	Method	Source
pointer	pass linked list	pointer address	Interface LLSC
cursor keys	edit record	direct input	user
menu item 1	cut/copy	direct input	user
menu item 2	paste selection	direct input	user

b. Local Data

(1) Edit Process

During the edit process, a temporary file consisting of the document being edited shall be created. To save main memory in the case of a large search process record, this file shall be maintained on disk, at the expense of slower access time. When editing is completed, this file shall either:

(a) Replace the original unedited search process record, which shall then be saved to disk; or

(b) Be saved to disk while maintaining the original search process record for further design search activities, or for later revising.

(2) Print Process

During the print process, a temporary print file shall be created from the search process record. This print file will be created on disk rather than in main memory to accommodate large search process records. When printing is complete, this temporary file shall be automatically deleted from disk.

c. Processing

(1) Control

Control shall automatically default into the Edit/Print LLSC upon entry into the Search Process Record component. Control shall be retained by the Edit/Print LLSC at all times while manipulating the Search Process Record data. Upon completion of Edit/Print operations, control shall be returned to the Design Aid Interface component.

(2) Algorithms

The Edit/Print LLSC shall be a standard text editor, with the ability to cut and paste whole graphic images. The Edit/Print LLSC shall implement algorithms for the modification, copying, cutting, and pasting of all files and individual parts of text files, and provide for access to the system print driver to print the resulting file.

(3) Special Control Features

Not Applicable.

(4) Error Handling

Four types of Edit/Print LLSC errors may occur:

(a) User requests to edit/print empty search process records.

User requests to edit/print empty search process records shall result in an error message being transmitted to the user, indicating the source of the error and directing the user to the option of selecting existing disk files.

(b) User request to edit portions of a graphics file.

User requests to edit portions of a graphics file shall result in an error message being transmitted to the user, indicating the source of the error.

(c) User requests to save edited search process records to disk.

User requests to save edited search process records to disk, when the lack of disk space will not permit, shall result in an error message being transmitted to the user, indicating the source of the error and directing the user to the option of saving the output on a floppy disk.

(d) User requests to print graphics outputs.

User requests to print graphics outputs, when the proper printer or printer drive is not available, shall result in an error message being transmitted to the user, indicating the source of the error and directing the user to the option of saving the output on a floppy disk.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

The external interface with the Edit/Print LLSC shall be the printer driver and printer. The LLSC shall have the capability to output to a laser or dot-matrix printer, given the appropriate printer driver.

d. Utilization of Other Elements

The Edit/Print LLSC shall be self-contained in its functions and shall not require utilization of elements outside of its designated storage and memory space. The Search Process Record itself shall exist in memory and shall be accessible from the Edit/Print LLSC.

e. Limitations

The size of the Search Process Record shall be limited by the amount of memory available in the hardware system. If memory reserves during a design search fall below 10% of main memory, a warning message shall be issued, accompanied by appropriate help instructions.

f. Outputs

The Edit/Print LLSC shall output its edited file into one of two output devices: the printer or the disk. The printer shall be the standard output device, and control shall default to hard copy output. The user shall be able to set the output device to be the hard disk or a floppy disk, and save the file to one of these media. The edited search process record may also be returned to the Design Aid Interface for further design search activities, via pointer address.

Output	Purpose	Method	Destination
data file	print record	temporary file	printer
data file	save record	file copy/transfer	floppy/hard disk
pointer	pass file	pointer address	Interface LLSC

3.2.3.3 Analysis TLSC

The Analysis component shall provide user-defined data manipulation functions to permit the examination of data. Analysis inputs and outputs shall be as diagrammed in Figure 3-9.

3.2.3.3.1 Requirements Allocation

The requirements of the Analysis component shall be divided into three sets of operations:

a. Descriptive Statistics

   Descriptive statistics shall provide the user with the capability to relate human parametric data to hardware design. All standard statistical operations shall be allocated to a lower level software design component designated as the Descriptive Statistics LLSC.

b. Transformations

   Transformation operations shall provide the user with the capability to derive new measures of human performance. All transformation operations shall be allocated to a lower level software design component designated as the Transformations LLSC.

c. Correlations/Predictions

   Correlation/Prediction operations shall provide the user with the capability to perform correlations and/or predictions of trends, or extrapolations of data. All correlation and prediction operations shall be allocated to a lower level software design component designated as the Correlations/Predictions LLSC.

3.2.3.3.2. Descriptive Statistics LLSC

The Descriptive Statistics LLSC shall provide the user with the capability to generate descriptive statistics on information stored in the Alphanumeric Data Base. As a minimum, the following descriptive statistic operations shall be included:

- mean
- median
- mode
- variance

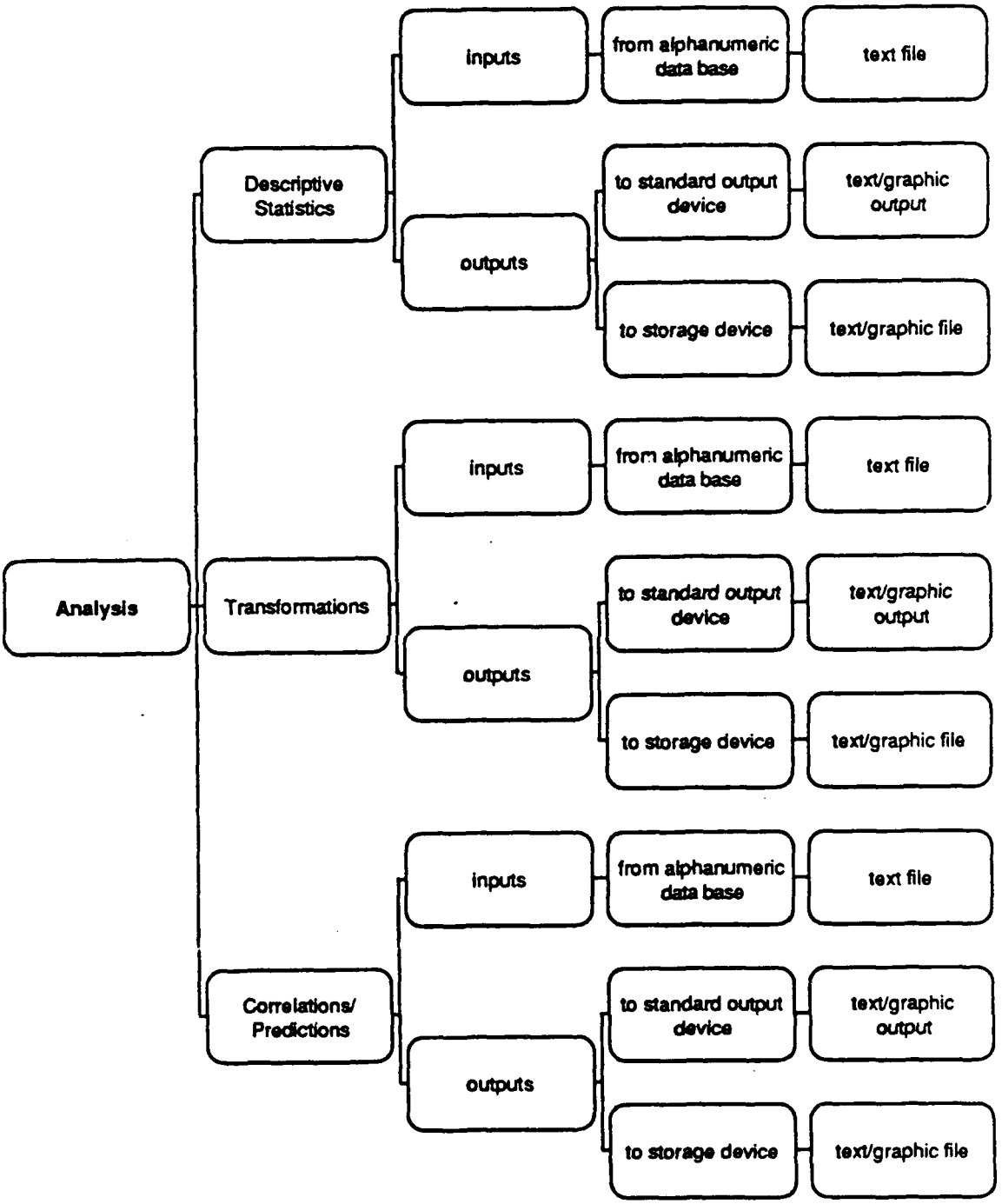

Figure 3-9. Analysis Input/Output Chart

- standard deviation
- standard error of the mean
- rimmed mean
- first and third quantile
- fifth and ninety-fifth percentile

a. Inputs

To activate the Descriptive Statistics component, the user shall be required to input the name of the data file or files to be analyzed, using the data file name and the redirection operator. When multiple variables exist within a single data file, the user shall have the option to specify a specific variable or set of variables within that file for evaluation. The default operation shall be evaluation on all variables within the file.

Input	Purpose	Method	Source
text file + optional variable(s)	data input	file name	Alphanumeric Data Base

b. Local Data

The Descriptive Statistics local data shall include:

(1) All manipulation of raw data into descriptions of central tendency and dispersion.

(2) All intermediate products, including but not limited to matrices, summations, and orderings.

(3) All output products.

c. Processing

(1) Control

Control shall be transferred to the Descriptive Statistics LLSC upon call from the Design Aid Interface for descriptive statistics operations. Control shall remain in this component until the

operation processing is complete, at which time control shall be transferred back to the Design Aid Interface.

(2) Algorithms

Standard algorithms shall be used in the creation of all statistical products. As all algorithms to be used in the Descriptive Statistics LLSC are straightforward and universal, they shall be cited from commercially available sources.

(3) Special Control Features

Not Applicable.

(4) Error Handling

The Descriptive Statistics LLSC may have two types of errors:

(a) Errors that occur when the user requests passage of a nonexistent data file or a nondata file to the component. For this type of error, execution shall be interrupted and an error message stating the probable cause of the error shall be transmitted to the user, along with associated help functions.

b. Errors that occur when the user requests passage of inappropriate data to the component (e.g., if the user requests descriptive statistics on nominal or ordinal data, such as telephone numbers). If meaningless results are received, the user can request help on meaningless data outputs, which would indicate the probable source of the error.

(5) Data Conversion

All alphanumeric data shall remain in the same form while in the Descriptive Statistics LLSC. All operations shall be conducted as floating point.

(6) Communication Interfaces

Not Applicable

d. Utilization of Other Elements

The Descriptive Statistics component is self-contained and shall not require utilization of elements outside of its designated storage

and memory space, except for the input file or files from the Alphanumeric Data Base.

e. Limitations

Not Applicable.

f. Outputs

The Descriptive Statistics LLSC shall output the results of its analysis directly to the Design Aid Interface in the form of ASCII alphanumeric data and stored in a temporary file for display to the user. The output shall be appended to the Search Process Record and deleted upon completion of the design aid session. The output may be saved for insertion into the Alphanumeric Data Base at a later time or saved as a Search Process Record file in accordance with user instructions.

Output	Purpose	Method	Destination
temporary file	display information	direct output	user
data file	save data	file copy/ transfer	storage device

3.2.3.3.3. Transformations LLSC

The Transformations LLSC shall provide the capability to manipulate data from the Alphanumeric Data Base according to a set of predefined and user-defined transformations and to prepare it for possible further evaluation.

a. Inputs

To activate the Transformations LLSC, the user shall be required to input the name of the data file to be analyzed, using the data file name and the redirection operator. When multiple variables exist within a single data file, the user shall have the option of specifying a specific variable or variables within that file for evaluation. The default operation shall be evaluation on all variables within the file. Provision shall also be made for the construction and use of user-defined transformations. The user shall be given a menu of predefined transformations that shall include the following:

- logarithmic
- log-log

- exponential
- powers
- roots
- straight lines

Input	Purpose	Method	Source
data file	data input	file name	Alphanumeric
+ optional variable(s)			Data Base
cursor keys	select transformation	direct input	user
ENTER	input transformation	direct input	user
equation	user-defined transform	direct input	user

b. Local Data

The Transformations LLSC local data shall include:

(1) All manipulation of raw data into descriptions of transforms.

(2) All intermediate products, including but not limited to matrices, summations, and orderings.

(3) All output products.

c. Processing

(1) Control

Control shall be transferred to the Transformations LLSC upon call from the Design Aid Interface for transformation processing operations. Control shall remain in the Transformations LLSC until the transformation processing is complete, at which time control shall be transferred back to the Design Aid Interface.

(2) Algorithms

Standard algorithms shall be used in the creation of all statistical products. As all algorithms to be used in the Transformations component are straightforward and universal, they shall be cited from commercially available sources.

(3) Special Control Features

Not Applicable

(4) Error Handling

The Transformations LLSC may have two types of errors:

(a) Errors that occur when the user requests passage of a nonexistent data file or a nondata file to the component. For this type of error, execution shall be interrupted and an error message stating the probable cause of the error shall be transmitted to the user, along with associated help instructions.

(b) Errors that occur when the user requests passage of inappropriate data to the component (e.g., if the user requests descriptive statistics on nominal or ordinal data, such as telephone numbers). If meaningless results are received, the user can request help on meaningless data outputs, which would indicate the probable source of the error.

(5) Data Conversion

All data shall remain in the same form while in the Transformations LLSC. All operations shall be conducted as floating point.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Transformations LLSC is self-contained and shall not require utilization of elements outside of its designated storage and memory space, except for the input file or files from the Alphanumeric Data Base.

e. Limitations

Not Applicable.

f. Outputs

The Transformations LLSC shall output the results of its analysis directly to the Design Aid Interface in the form of ASCII alphanumeric data and stored in a temporary file for display to the user. The output shall be appended to the Search Process Record and deleted upon completion of the design aid session. The output may be saved for insertion into the Alphanumeric Data Base at a later time or saved as a Search Process Record file in accordance with user instructions.

Output	Purpose	Method	Destination
temporary file	display transformation	direct output	user
data file	save data	file copy/ transfer	storage device

3.2.3.3.4 Correlation/Predictions LLSC

The Correlation/Predictions LLSC shall provide the capability for the user to investigate the relationships between variables, and to use those relationships to make extrapolations or predictions based on those relationships. The user shall have the capability to select, one at a time, the following standard statistical procedures:

- Pearson's (r) correlation
- Spearman's (rho) correlation
- simple and multiple least squares regression
- moving average time series models
- autoregressive time series models
- ARIMA time series models

a. Inputs

To activate the Correlations/Predictions LLSC, the user shall be required to input the name of the data file to be analyzed, using the data file name and the redirection operator. When multiple variables exist within a single data file, the user shall have the option of specifying a specific variable or variables within that file

for evaluation. The default operation shall be evaluation on all variables within the file.

Input	Purpose	Method	Source
text file + optional variable(s)	data input	file name	Alphanumeric Data Base

b. Local Data

The Correlations/Predictions LLSC local data shall include:

(1) All manipulation of raw data into descriptions of transforms.

(2) All intermediate products, including but not limited to matrices, summations, and orderings.

(3) All output products.

c. Processing

(1) Control

Control shall be transferred to the Correlations/Predictions LLSC upon call from the Design Aid Interface for transformation processing operations. Control shall remain in this component until the transformation processing is complete, at which time control shall be transferred back to the Design Aid Interface.

(2) Algorithms

Standard algorithms shall be used in the creation of all statistical products. As all algorithms to be used in the Correlations/Predictions LLSC are straightforward and universal, they shall be cited from commercially available sources.

(3) Special Control Features

Not Applicable.

(4) Error Handling

The Correlation/Predictions LLSC may have two types of errors:

(a) Errors that occur when the user requests passage of a nonexistent data file or a nondata file to the component. For this type of error, execution shall be interrupted and an error message stating the probable cause of the error shall be transmitted to the user, along with associated help functions.

(b) Errors that occur when the user requests passage of inappropriate data to the component (e.g., if the user requests descriptive statistics on nominal or ordinal data, such as telephone numbers). If meaningless results are received, the user can request help on meaningless data outputs, which would indicate the probable source of the error.

(5) Data Conversion

All data shall remain in the same form while in the Correlations/Predictions LLSC. All operations shall be conducted as floating point.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Correlations/Predictions LLSC is self-contained and shall not require utilization of elements outside of its designated storage and memory space.

e. Limitations

The Transformations LLSC shall accept both formatted and unformatted data files as input.

f. Outputs

The Correlations/Predictions LLSC shall output the results of its analysis directly to the Design Aid Interface in the form of ASCII alphanumeric data and stored in a temporary file for display to the user. The output shall be appended to the Search Process Record and deleted upon completion of the design aid session. The output may be saved for insertion into the Alphanumeric Data Base at a later time or saved as a Search Process Record file in accordance with user instructions.

Output	Purpose	Method	Destination
temporary file	display information	direct output	user
data file	save information	file copy/ transfer	storage device

3.2.3.4 Knowledge Acquisition Interface TLSC

The Knowledge Acquisition Interface shall provide the Product 3 software system with the means of adding new information and modifying old information in the data files. This component shall be accessible from the Design Aid Interface component only. Component inputs and outputs shall be as diagrammed in Figure 3-10. The Knowledge Acquisition Interface TLSC shall be divided into two lower level software components (LLSCs):

a. Manual Update LLSC

The Manual Update LLSC shall provide the capability for the user to make discrete modifications in individual data files as new information becomes available. It shall not have the capability to add or modify existing graphic data files. The Manual Update LLSC shall have the capability to guide the user to the desired data file or set of files through the use of a taxonomy similar to that used in the design search operations. This LLSC shall provide for a hierarchical ordering of human characteristics, to provide the user with the capability to select progressively more detailed characteristics until a single file or a maximum subset of three files have been selected as the most likely candidates for the input and/or deletion of data. However, the system shall also provide the capability for a user to select a file directly and enter the desired changes, if the name of the file to be updated is known.

b. Automated Update LLSC.

The Automated Update LLSC shall permit the user to enter entire updated or new files into both the Alphanumeric and Graphics Data Bases. These files may be located on either a floppy disk or Bernoulli removable hard disk. This component shall also connect the data structures that supply the links between the design search taxonomy and the individual data files.

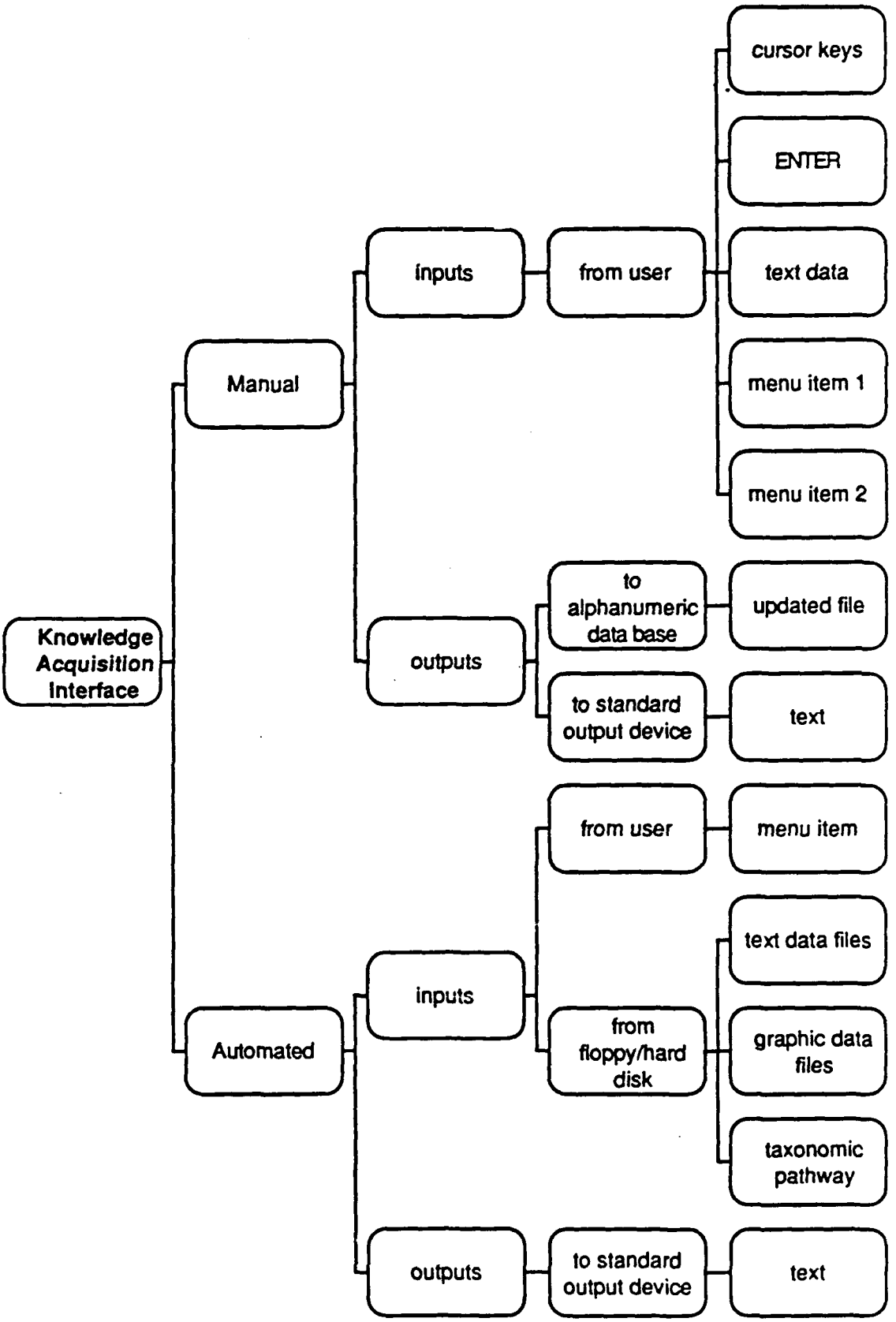

Figure 3-10. Knowledge Acquisition Interface Input/Output Chart

3.2.3.4.1 Knowledge Acquisition Interface Requirements Allocation

The Knowledge Acquisition Interface shall address the following requirements: file selection and file modification. These functions shall also exist in two different states of operation: manual, in which the user selects and updates by direct input from the keyboard; and automatic, where selection and updating is done by a previously-prepared floppy disk without input from the keyboard. These requirements shall be fulfilled by two lower level components: the Manual Update LLSC and the Automatic Update LLSC.

3.2.3.4.2 Manual Update LLSC

The Manual Update LLSC shall permit the user to make discrete modifications in individual data files as new information becomes available.

a. Inputs

The Manual Update LLSC shall have the capability to accept instructions to search, identify, and select desired files through the use of the Product 3 workstation keyboard. These inputs shall accomplish two purposes:

(1) Permit the user to locate and open a text data file.

(2) Permit the user to modify the opened file.

Input	Purpose	Method	Source
cursor keys	locate data files	direct input	user
ENTER	select/open files	direct input	user
text data	update data files	direct input	user
menu item 1	close data file	direct input	user
menu item 2	save/delete changes	direct input	user

b. Local Data

No local data shall be created in the Manual Update LLSC except for those variables necessary to carry out the text editing function.

c. Processing

(1) Control

Control shall automatically default into the Manual Update LLSC upon entrance into the Knowledge Acquisition Interface component. The component shall provide the user with the capability to continue with the manual updating process, or transfer into the Automatic Update LLSC. All text data file location, selection, opening, closing, and text editing shall occur from within the Manual Update LLSC. The component shall access data base files belonging to the Alphanumeric Data Base component.

(2) Algorithms

Manual Update LLSC algorithms consist of readily available commercial structures for standard file open, file close, and text editing functions used in this component.

(3) Special Control Features

Not Applicable.

(4) Error Handling

The Manual Update LLSC may have two types of errors generated:

(a) Requesting nonexisting data file to be opened. The system shall transmit an error message for display to the user, indicating the probable cause(s). The error message shall be accompanied by related Help instructions.

(b) Inadvertent update of incorrect files. No error message will be available to signal this type of error; however, the system shall automatically provide the user with the opportunity to review the edits prior to saving the input data.

(c) Data Conversion

Not Applicable

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Manual Update LLSC shall make use of the Alphanumeric Data Base component in the update process. If a new text data file is being added by the manual update method, this component shall also access the Design Aid Interface component in order to form a new taxonomic pathway to that file, so that it can be accessed and displayed to the user as required.

e. Limitations

Not Applicable.

f. Outputs

The Manual Update LLSC outputs only textual information and only to the standard output device.

Output	Purpose	Method	Destination
text	update process	direct output	user

3.2.3.4.3 Automated Update LLSC

The Automated Update LLSC shall provide the system with the capability to make major modifications or add entirely new text files to the Alphanumeric Data Base, or to add bit-mapped graphics files to the Graphics Data Base. These updates shall be done by way of a floppy disk or Bernoulli removable hard disk. Disks used for this purpose shall contain the text and Graphics Data Base files for updating, and the pathways from the Design Aid Interface to the new files or modified files, if necessary.

a. Inputs

There shall be four types of inputs into the Automatic Update LLSC; instructions from the user to start the automatic update process, text files for inclusion in the Alphanumeric Data Base component, graphics files for inclusion in the Graphics Data Base component, and new or amended pathways to these files for inclusion in the Design Aid Interface component.

Input	Purpose	Method	Source
keystrokes	direct update process	direct input	user
text data files	update data base	direct input	disk
graphic data files	update data base	direct input	disk
pathways	update data links	direct input	disk

b. Local Data

Not Applicable.

c. Processing

(1) Control

Control shall automatically default into the Manual Update LLSC upon entrance into the Knowledge Acquisition Interface component. The Manual Update LLSC shall provide the user with the capability to transfer into the Automatic Update component. In the Automatic Update option, the user shall insert the floppy or Bernoulli disk containing the update files and pathways. The Automatic Update LLSC shall access data base files belonging to the Alphanumeric and Graphics Data Base components. Once all automatic file modifications and new pathway constructions are completed, the Automatic Update LLSC shall automatically transfer control back to the Manual Update LLSC for further update exercises or for exit from the Knowledge Acquisition Interface.

(2) Algorithms

Not Applicable.

(3) Special Control Features

Not Applicable.

(4) Error Handling

The Automated Update LLSC may have two types of errors generated:

a. Insufficient storage space on the mass storage device to include the new or updated data files. The user shall

receive a message that insufficient space exists for that operation.

b. Unauthorized file name changes may result in the creation of two different files, the new and the old, each with separate taxonomic pathways. This shall not cause a system error, but may present redundant design information to the user. No error message will be available to signal this type of error; however, repetitions of output will enable the user to recognize this situation.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Automatic Update LLSC shall make use of the Alphanumeric and Graphics Data Base components in the update process. If a new text data file is being added by the manual update method, this LLSC shall also access the Design Aid Interface component in order to form a new taxonomic pathway to that file, so that it can be accessed and displayed to the user as required.

e. Limitations

Not Applicable.

f. Outputs

The Automatic Update LLSC outputs only textual information and only to the standard output device. This textual information shall convey the status of the automatic update process while in progress.

Output	Purpose	Method	Destination
text	update status	direct output	user

3.2.3.5 Training/Help TLSC

The Training/Help TLSC is divided into two Lower Level Software Components (LLSCs): the Training LLSC and the Help LLSC. Component inputs and outputs shall be as diagrammed in Figure 3-11.

3.2.3.5.1 Training/Help Requirements Allocation

The requirements of the Training/Help TLSC can be divided into two types of operations: the requirement to introduce a new user to the functionality of MANPRINT Product 3, and the requirement to assist an inexperienced or casual user who may have an understanding of Product 3 functionality, but may not be sufficiently familiar with the software system to independently direct a specific design search process. The first requirement will fall in the category of training in the philosophy and general approach of the software system, while the second requirement will go beyond initial training into assistance (help) for specific situations in the design search process. Therefore, these primary functions shall be divided into two Lower Level Software Components.

3.2.3.5.2 Training LLSC

The Training LLSC shall provide the user with an initial orientation into the functionality and procedures of the Product 3 software system.

a. Inputs

Entry into the Training LLSC shall cause the system to begin an automatic simulated design search. This sample design search shall be conducted step by step to permit the user to observe the process and note the functions available. In addition, the user shall be able to:

(1) Start the sample design search,

(2) Pause at any part of the sample design search to more closely examine a feature,

(3) Abort the sample design search in progress, and

(4) Leave the Training component and return to the Design Aid Interface component.

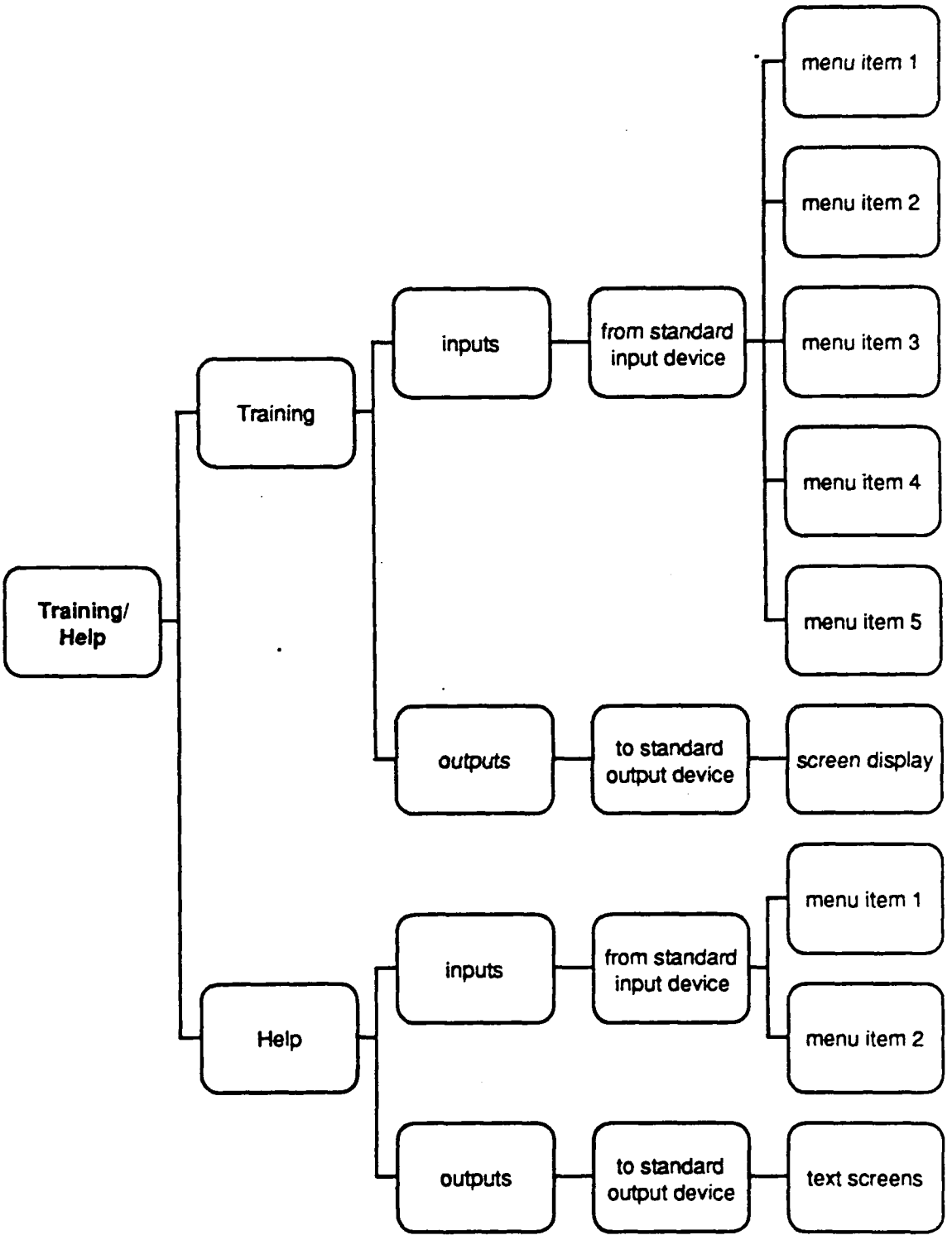

Figure 3-11. Training/Help Input/Output Chart

Input	Purpose	Method	Source
Menu Item 1	Begin training (while in Design Aid Interface component)	Input from keyboard	User
Menu Item 2	Begin sample search	Input from keyboard	User
Menu Item 3	Pause search	Input from keyboard	User
Menu Item 4	Abort search	Input from keyboard	User
Menu Item 5	Quit training	Input from keyboard	User

b. Local Data

Training LLSC local data shall consist of programmed instructions for the conduct of the sample design search. These instructions shall be written in the Revelation terminal control language so that the instructions can access and direct the other components in the execution of the sample search.

c. Processing

(1) Control

The Training LLSC shall receive system control upon manual transfer by the user from the Design Aid Interface TLSC. Control shall be maintained by this LLSC throughout the sample design search, although it calls several of the other TLSCs in order to execute the simulated search.

(2) Algorithms

Standard data structures and manipulation procedures shall be required to implement this LLSC. The standard data structures shall take user keystrokes as input, and select the appropriate display from a tree structure (Figure 3-5), in which the displays are accessed via pointers. The display shall then be mapped into the standard output device.

(3) Special Control Features

Not Applicable.

(4) Error Handling

Only one user-initiated error is possible from the Training LLSC. Given user selection of a key not associated with a legitimate system operation, a prompt shall appear at the bottom of the screen, indicating operations available from that point and the actions necessary to implement those operations. Internal errors may occur if the Training LLSC attempts to transfer control to a non-existent component. For such errors, an error message shall be output, indicating the source of the error and providing accompanying help instructions.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Training LLSC shall call on the Interface LLSC in the accomplishment of the conduct of a sample design aid session. Through the Interface LLSC, it shall have the capability to call the Search Process Record and Analysis components directly, and Alphanumeric and Graphics Data Base components indirectly through the Data Access LLSC.

e. Limitations

Not Applicable.

f. Outputs

Outputs from the Training LLSC shall consist of the series of screen displays that constitute the sample design aid session. These screen displays shall be returned directly to the user via the standard output device and are not saved, except in the search process record constructed during the sample session. The search process record constructed during a training session shall be deleted prior to leaving the Training LLSC.

Output	Purpose	Method	Destination
screen displays	sample design search	direct output	user

3.2.3.5.3 Help LLSC

The Help LLSC shall provide the user with situational prompts and assistance at all decision points in a design search.

a. Inputs

The Help LLSC shall accept two user inputs, both function keys input by the user, to enable the user to enter and exit the help files.

Input	Purpose	Method	Source
Menu Item 1	enter HELP	direct input	user
Menu Item 2	exit HELP	direct input	user

b. Local Data

The Help LLSC local data shall consist of textual data that comprise the text of the help messages.

c. Processing

(1) Control

Given a user request for a help screen, the Help LLSC shall receive system control automatically from the Interface LLSC. Once the user has completed with the help message, control shall be transferred back to the Design Aid Interface.

(2) Algorithms

Not Applicable.

(3) Special Control Features

Not Applicable.

(4) Error Handling

Not Applicable.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Help LLSC is self-contained and uses no elements from other components, except for inputs as noted above.

e. Limitations

Not Applicable.

f. Outputs

The Help LLSC shall output textual data to the standard output device. This textual data represents the contents of the situational assistance provided to the user during the course of a design search.

Output	Purpose	Method	Destination
text scre ›ns	provide assistance	direct output	Design Aid Interface

3.2.3.6 Alphanumeric Data Base TLSC

The Alphanumeric Data Base component shall consist of all prestored text and numeric files containing data on significant soldier characteristics. These files shall be created using text editors or data file transfer mechanisms, and stored on the Product 3 mass storage device. These alphanumeric files may be modified or altered by an authorized user using the Knowledge Acquisition Interface, and may be replaced either partially or in their entirety in order to update their information. Information from these files shall be derived from a number of sources; these sources and the categories of data to be taken from them are included in Appendix IV. Component inputs and outputs shall be as diagrammed in Figure 3-12.

3.2.3.6.1 Requirements Allocation

As no functionality exists in this top level component, no sepa ate lower level components are required. The entire data base shall be equally accessible to the Design Aid Interface for locating and displaying alphanumeric design aid information.

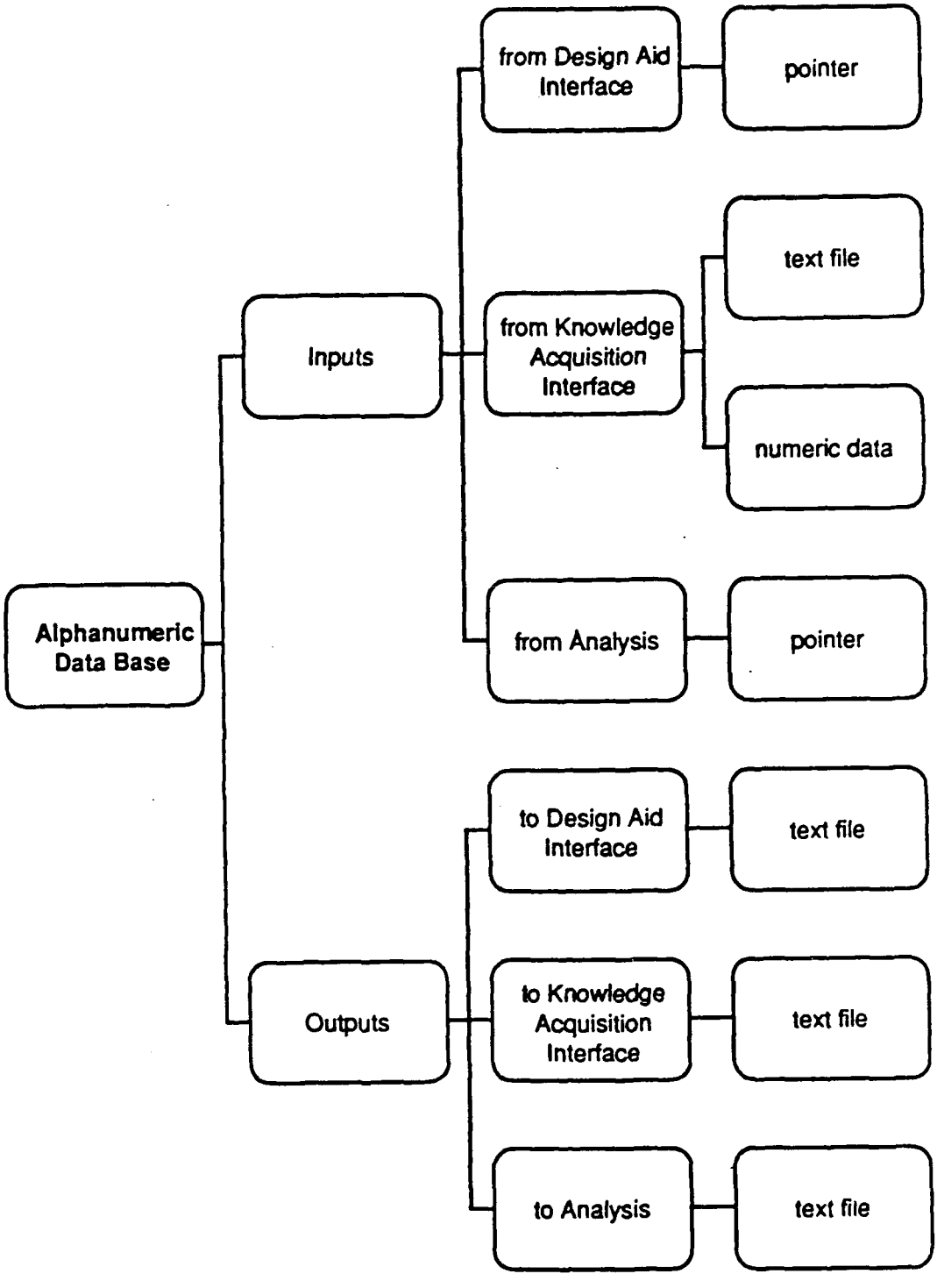

Figure 3-12. Alphanumeric Data Base Input/Output Chart

3.2.3.6.2 Alphanumeric Data Base Component

a. Inputs

Inputs into the Alphanumeric Data Base component shall be the pointer or pointers designating the alphanumeric file or files to be accessed as a result of three possible processes:

(1) The design search process from the Design Aid Interface component.

(2) A request for numerical information for statistical evaluation from the Analysis component.

(3) A request for file display and/or edit from the Knowledge Acquisition Interface component.

Input	Purpose	Method	Source
pointer	select file	pointer address	Design Aid Interface, Analysis, Knowledge Acquisition Interface

b. Local Data

No local data shall exist in the Alphanumeric Data Base component. The data base information itself shall be considered global, as it is accessible by several top level components. The data base structure and format is discussed in detail in Appendix V.

c. Processing

(1) Control

Control shall never be transferred to the Alphanumeric Data Base component. It shall accept a pointer and return the file designated by that pointer.

(2) Algorithms

Not Applicable.

(3) Special Control Features

Not Applicable.

(4) Error Handling

Not Applicable.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

The Alphanumeric Data Base shall not utilize other elements in the system.

e. Limitations

The Alphanumeric Data Base shall be limited only by the amount of mass storage space available to store textual files. The system shall warn the user when disk reserves drop below 10% of total disk space.

f. Outputs

The Alphanumeric Data Base component shall output the alphanumeric file or files specified as by the input pointer to one of three possible components:

(1) The Design Aid Interface component for display.

(2) The Analysis component for statistical evaluation.

(3) The Knowledge Acquisition Interface component for display and editing/updating.

Output	Purpose	Method	Destination
alphanumeric file	display information	direct output	Design Aid Interface, Analysis, Knowledge Acquisition Interface

3.2.3.7 Graphics Data Base TLSC

The Graphics Data Base component shall consist of all prestored bit-mapped graphics files containing data on significant soldier characteristics. These files shall be created by scanning and digitizing already-existing graphs, charts and pictures, and using a bit-mapped graphics compression algorithm to store them in compressed form on the Product 3 mass storage device. These graphics files shall not be in any way modified or altered by manual data entry operations, and must be replaced in their entirety in order to update their information. Information from these files shall be derived from a number of sources; these sources and the categories of graphics to be taken from them are included in Appendix IV. Component inputs and outputs shall be as diagrammed in Figure 3-13.

3.2.3.7.1 Requirements Allocation

As no functionality exists in this top level component, no separate lower level components are required. The entire data base shall be equally accessible to the Design Aid Interface for locating and displaying graphical design aid information.

3.2.3.7.2 Graphics Data Base Component

a. Inputs

Inputs into the Graphics Data Base component shall be the pointer or pointers designating the graphics file or files to be accessed and displayed as a result of one of two types of processes:

(1) The design search process from the Design Aid Interface.

(2) The information update process from the Knowledge Acquisition Interface.

Input	Purpose	Method	Source
pointer	select file	pointer address	Design Aid Interface, Knowledge Acquisition Interface

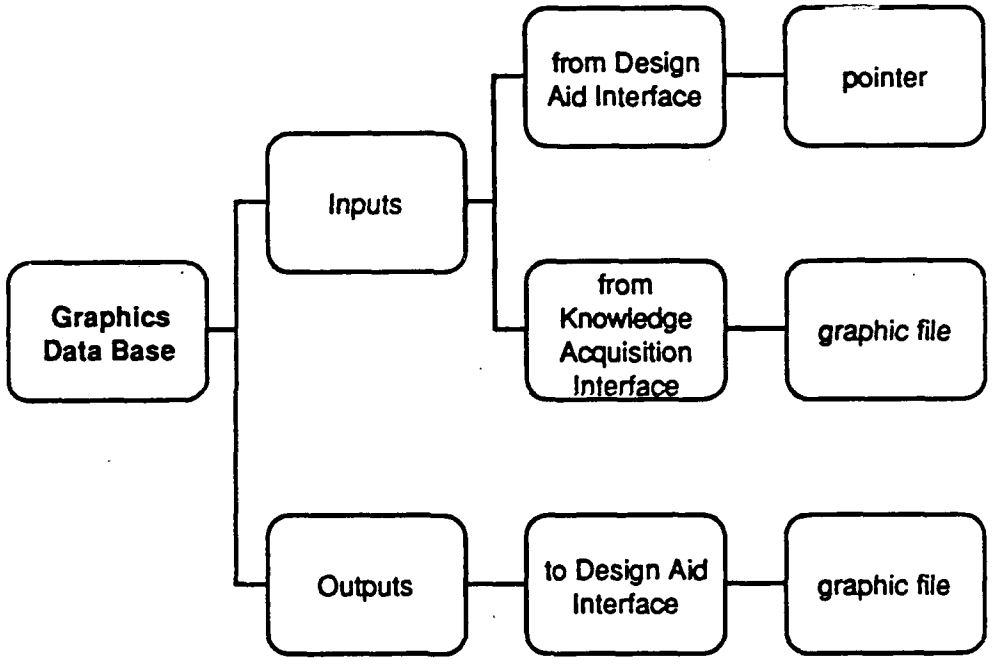

Figure 3-13. Graphics Data Base Input/Output Chart

b. Local Data

No local data shall exist in the Graphics Data Base component. The data base information itself shall be considered global, as it is accessible by several top level components. The data base structure and format is discussed in detail in Appendix V.

c. Processing

(1) Control

Control shall never be transferred to the Graphics Data Base component. It shall accept a pointer and return the file designated by that pointer.

(2) Algorithms

Not Applicable.

(3) Special Control Features

Not Applicable.

(4) Error Handling

Not Applicable.

(5) Data Conversion

Not Applicable.

(6) Communication Interfaces

Not Applicable.

d. Utilization of Other Elements

Not Applicable.

e. Limitations

The Graphics Data Base shall be limited only by the amount of mass storage space available to store bit-mapped graphics files. The system shall warn the user when disk reserves drop below 10% of total disk space.

f. Outputs

The Graphics Data Base component shall output to the Design Aid Interface component the bit-mapped graphics file or files specified as by the input pointer.

Output	Purpose	Method	Destination
graphics file	display information	direct output	Design Aid Interface

4.0 Quality Assurance Provisions

4.1 Introduction and Definitions

A program of tests, inspections and demonstrations, augmented by analysis, shall be conducted to verify compliance of the Product 3 specification requirements as stated in Section 3. These verification methods are defined herein.

a. Inspection

Verification by examination of the item, reviewing descriptive documentation, and comparing the appropriate characteristics with a predetermined standard to determine conformance to requirements without the use of special laboratory equipment or procedures.

b. Analysis

Verification by technical evaluation using mathematical representations, charts, graphs, circuit diagrams, data reduction, and/or representative data.

c. Demonstration

Verification by operation, movement, and/or adjustment of the item under specific conditions to perform the design function without recording of quantitative data.

d. Test

Verification through systematic exercising of the applicable item under appropriate conditions with instrumentation to measure required parameters and the collection/analysis/evaluation of quantitative data to show that measured parameters equal or exceed specified requirements.

Table 4-1 specifies by paragraph the Verification method(s) that shall be used to confirm that this requirements specification complies with the requirements as stated in Section 3. The major test phases are:

a. 18 Month Demonstration

b. 24 Month Acceptance Test

4.2 18 Month Demonstration

The 18 Month demonstration will consist of informal testing performed to obtain confidence and knowledge during the evolution of the software and to isolate and correct anomalies. The demonstration shall be performed on equipment that meets the requirements of the Army Research Institute Product Integration Rules, dated 31 July 1987.

4.3 24 Month Acceptance Test

The 24 Month Acceptance Test will consist of formal qualification and acceptance of the prototype system and will include verification of requirements which could not be validated in the 18 Month Demonstration or to demonstrate correction of anomalies.

4.4 Verification Cross Reference Matrix (VCRM)

Table 4-1 contains the VCRM for this specification. For each testable requirement in Section 3, the VCRM specifies the Verification method which will be used and the test phase when the Verification will occur.

The columns in the VCRM describe:

a. Requirement Paragraph Number

The Section Number of the paragraph in Section 3 which describes the Testable requirement.

b. Paragraph Title

The Section 3 Title of the section which contains the testable requirements.

c. Verification Method

A set of 5 columns which indicate the method(s) that will be used to verify a testable requirement or to indicate that a requirement is a non-testable requirement. Verification Methods include:

N	Non Testable Requirement
I	Inspection
A	Analysis
D	Demonstration
T	Test

d. Test Category

A set of 2 columns which indicate the Test Category when the testable requirement will be verified. Possible Test Categories are:

A	I8 Month Demonstration Test
B	24 Month Acceptance Test

Table 4-1 Verification Cross Reference Matrix

Method Legend
N = No Testable Requirement
I = Inspection
A = Analysis
T = Test
D = Demonstration

Test Category Legend
A = 18 Months Demo Test
B = 24 Months Accept Test

Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.0	Design Requirements	x						
3.1	Top Level Design Requirements	x						
3.1.1	Software Architecture					x	x	
3.1.1.1	Design Aid Interface Component				x		x	x
3.1.1.2	Search Process Record Component				x		x	x
3.1.1.3	Analysis Component				x		x	x
3.1.1.4	Knowledge Acquisition Interface Component				x		x	x
3.1.1.5	Training/Help Component				x		x	x
3.1.1.6	Alphanumeric Data Base Component					x		x
3.1.1.7	Graphics Data Base Component					x		x
3.1.2	Functional Allocation				x		x	
3.1.3	Memory And Processing Time Allocation	x						
3.1.3.1	Memory Allocation				x			x
3.1.3.2	System Response Times				x			x
3.1.4	Functional Control And Data Flow	x						
3.1.4.1	Functional Control					x		x
3.1.4.2	DataFlow					x		x
3.1.5	Global Data					x		x
3.1.6	Top Level Design	x						

Table 4-1 Verification Cross Reference Matrix

Method Legend
N = No Testable Requirement
I = Inspection
A = Analysis
T = Test
D = Demonstration

Test Category Legend
A = 18 Months Demo Test
B = 24 Months Accept Test

Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.1.6.1	Design Aid Interface TLSC	x						
3.1.6.1.1	Purpose				x			x
3.1.6.1.2	Objective					x	x	
3.1.6.1.3	General Description					x	x	
3.1.6.1.4	Inputs					x	x	x
3.1.6.1.5	Local Data	x						
3.1.6.1.6	Sequencing					x	x	
3.1.6.1.7	Processing					x	x	
3.1.6.1.8	Outputs					x	x	x
3.1.6.2	Search Proces Records TLSC	x						
3.1.6.2.1	Purpose				x			x
3.1.6.2.2	Objective					x	x	
3.1.6.2.3	General Description					x	x	
3.1.6.2.3.1	Data Handling				x			x
3.1.6.2.3.2	Editing Capability				x			x
3.1.6.2.4	Inputs					x		x
3.1.6.2.4.1	Data Base Inputs					x		x
3.1.6.2.4.2	Design Aid Interface Component					x	x	
	Inputs					x	x	x

Table 4-1 Verification Cross Reference Matrix

Method Legend
N = No Testable Requirement
I = Inspection
A = Analysis
T = Test
D = Demonstration

Test Category Legend
A = 18 Months Demo Test
B = 24 Months Accept Test

Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.1.6.2.5	Local Data					x	x	
3.1.6.2.6	Sequencing					x	x	
3.1.6.2.7	Processing					x	x	
3.1.6.2.8	Outputs					x	x	x
3.1.6.3	Analysis TLSC	x						
3.1.6.3.1	Purpose				x			x
3.1.6.3.2	Objective					x	x	
3.1.6.3.3	General Description					x	x	
3.1.6.3.4	Inputs					x	x	x
3.1.6.3.5	Local Data					x	x	
3.1.6.3.6	Sequencing					x	x	
3.1.6.3.7	Processing					x	x	
3.1.6.3.8.	Outputs					x	x	x
3.1.6.4	Knowledge Acquistion Interface TLSC	x						
3.1.6.4.1	Purpose				x			x
3.1.6.4.2	Objective					x	x	
3.1.6.4.3	General Description					x	x	
3.1.6.4.4	Inputs					x	x	x
3.1.6.4.5	Local Data					x	x	
3.1.6.4.6	Sequencing					x	x	

Table 4-1 Verification Cross Reference Matrix

Method Legend
N = No Testable Requirement
I = Inspection
A = Analysis
T = Test
D = Demonstration

Test Category Legend
A = 18 Months Demo Test
B = 24 Months Accept Test

Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.1.6.4.7	Processing					x	x	
3.1.6.5.3.1.	Outputs					x	x	x
3.1.6.5	Training/Help TLSC	x						
3.1.6.5.1	Purpose				x			x
3.1.6.5.2	Objective	x						
3.1.6.5.2.1	Training Objective					x	x	
3.1.6.5.2.2	Help Objective					x	x	
3.1.6.5.3	General Description	x						
3.1.6.5.3.1	Training					x	x	
3.1.6.5.3.2	Help					x	x	
3.1.6.5.4	Inputs					x	x	x
3.1.6.5.5	Local Data					x	x	
3.1.6.5.6	Sequencing					x	x	
3.1.6.5.7	Processing					x	x	
3.1.6.5.8	Outputs					x	x	x
3.1.6.6	Alphanumeric Data Base TLSC	x						
3.1.6.6.1	Purpose				x			x
3.1.6.6.2	Objective					x	x	

Table 4-1 Verification Cross Reference Matrix

Method Legend
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Test Category Legend
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Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.1.6.6.3	General Description					x	x	
3.1.6.6.4	Inputs					x	x	x
3.1.6.6.5	Local Data					x	x	
3.1.6.6.6	Sequencing					x	x	
3.1.6.6.7	Processing					x	x	
3.1.6.6.8	Outputs					x	x	x
3.1.6.7	Graphics TLSC	x						
3.1.6.7.1	Purpose				x			x
3.1.6.7.2	Objective					x	x	
3.1.6.7.3	General Description					x	x	
3.1.6.7.4	Inputs					x	x	x
3.1.6.7.5	Local Data					x	x	
3.1.6.7.6	Sequencing					x	x	
3.1.6.7.7	Processing					x	x	
3.1.6.7.8	Outputs					x	x	x
3.1.7	Adaptation Data					x		x
3.1.8	System Maintenance					x		x
3.1.8.1	Data Base Maintenance					x		x
3.1.8.2	Account/Access Maintenance					x		x

Table 4-1 Verification Cross Reference Matrix

Method Legend
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Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.2	Detailed Design Requirements	x						
3.2.1	Interface Design	x						
3.2.1.1	Design Aid Interfaces					x	x	
3.2.1.1.1	Design Aid Interface/Search Process Record					x	x	
3.2.1.1.2	Design Aid Interface/Analysis					x	x	
3.2.1.1.3	Design Aid Interface/Knowledge Acquisition					x	x	
3.2.1.1.4	Design Aid Interface/Training/Help					x	x	
3.2.1.1.5	Design Aid Interface/Alphanumeric Data Base					x	x	
3.2.1.1.6	Design Aid Interface/Graphics Data Base					x	x	
3.2.1.2	Search Process Record Interfaces	x						
3.2.1.2.1	Search Process Record/Alpha-numeric Data Base					x	x	
3.2.1.2.2	Search Process Record/Graphics Data Base					x	x	
3.2.I.3	Analysis/Alphanumeric Data Base					x		

Table 4-1 Verification Cross Reference Matrix

Method Legend
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A = Analysis
T = Test
D = Demonstration

Test Category Legend
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Required Paragraph Number	Paragraph Title	Verify Method					Test Category	
		N	I	A	T	D	A	B
3.2.1.4	Knowledge Acquisition Interface	x						
3.2.1.4.1	Knowledge Acquisition Interface/ Alphanumeric Data Base					x	x	x
3.2.1.4.2	Knowledge Acquisition Interface/ Graphics Data Base					x	x	x
3.2.2	Global Data					x	x	x
3.2.3	Detailed Design		x	x		x	x	x
3.2.3.1	Design Aid Interface TLSC					x	x	x
3.2.3.1.1	Design Aid Interface Requirements Allocations					x	x	
3.2.3.1.2	Interface LLSC					x	x	x
3.2.3.1.3	Data Base Access LLSC					x	x	x
3.2.3.2	Search Process Record TLSC					x	x	
3.2.3.2.1	Search Process Record					x	x	x
	Requirements Allocation					x	x	
3.2.3.2.2	Create LLSC					x	x	x
3.2.3.2.3	Edit/Print LLSC					x	x	x
3.2.3.3	Analysis TLCS					x	x	x
3.2.3.3.1	Requirements Allocation					x	x	
3.2.3.3.2	Descriptive Statistics LLSC					x	x	x
3.2.3.3.3	Transformations LLSC					x	x	x

Table 4-1 Verification Cross Reference Matrix

Method Legend
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Test Category Legend
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Required Paragraph Number	Paragraph Title	Verify Method N	I	A	T	D	Test Category A	B
3.2.3.4	Correlations/Prediction TLSC					x	x	x
3.2.3.4.1	Knowledge Acquisition Interface Requirements Allocation					x	x	
3.2.3.4.2	Manual Update LLSC					x	x	x
3.2.3.4.3	Automated Update LLSC					x	x	x
3.2.3.5	Training/Help TLSC					x	x	x
3.2.3.5.1	Training/Help Requirements Allocation					x	x	
3.2.3.5.2	Training LLSC					x	x	x
3.2.3.5.3	Help LLSC					x	x	x
3.2.3.6	Alphanumeric Data Base TLSC					x		x
3.2.3.6.1	Requirements Allocation					x		x
3.2.3.6.2	Alphanumeric Data Base Component					x		x
3.2.3.7	Graphics Data Base					x		x
3.2.3.7.1	Requirements Allocation					x		x
3.2.3.7.2	Graphics Data Base Component					x		x

5.0 PREPARATION FOR DELIVERY

5.1 General

This section details only the preparation of the actual computer programs in the form of machine readable media.

5.2 Specific Requirements

The following MANPRINT Product 3 software program elements shall be delivered:

a. One set of removable cartridge and floppy disk media.

b. One set of paper listings plus copies on magnetic media.

5.3 Detailed Preparation

5.3.1 Preservation and Packaging

The delivered media should be marked with the system name, version, and release data, plus the word "MASTER." The marking shall be on a self adhesive label attached to the media.

A directory of the contents of the media, keyed to the associated documentation, should be inserted into the container (envelope or canister).

5.3.2 Packaging

The delivery media shall be packaged according to good commerical practice.

5.3.3 Marking For Shipment

The delivered media shall be packaged according to good commerical practice.

6.0 NOTES

6.1 Training and Help

6.1.1 Philosophy

The philosophy underlying the approach to training and help on Product 3 is derived from the System Integration Guidelines provided by the Army Research Institute:

Training will be handled by a "self-evident" interface and/or built in help. Whenever external training (documentation or instruction) is called for, it must be accompanied by an explanation as to why this could not be accomplished by the interface and/or help.

6.1.2 Goals

The goal, therefore, is to produce a system that is as self-contained as possible. While this is a noteworthy goal, in practice there are circumstances in which Product 3 should in fact have off-line written documentation. This documentation need not be provided directly to the user, however. For example, it is important for the Army Research Institute (ARI) to have an explicit guide on configuring, installing, and maintaining the Product 3 software system, presuming that they are going to be supporting the system in the field installations. As such, ARI requires documentation on these functions in order to provide the required support. The documentation provided by ARI to the user in the field will draw upon the information already available at ARI, but may be somewhat less in scope.

6.1.3 Installation/Maintenance Documentation

In a software system this complex, for example, there is no question that when it is distributed to the field it should be accompanied by installation instructions. The system manager will require instruction on the proper configuration of the system, before it is even used. This is particularly true in light of the fact that it will have the ability to run off a Bernoulli disk or a fixed hard disk. These instructions will be provided by ARI, based on the installation guide provided to ARI with Product 3. Furthermore, these instructions may well be included in the transmittal letter, consisting of perhaps two pages or so.
It is also necessary to provide documentation for the user. As much of this documentation as possible will be provided on-line. Product 3 must be designed for the user with little or no computer experience, who may not even be able to reach a point in the system at which a Help function will be useful. For a new user such as this, it is important for a training aid to take them through every step of a session, from turning of the system at the beginning to

turning it off at the end. At the same time, Product 3 may have a moderately experienced user who, however, does not use the system often enough to remember the results of all options and selections. For this type of individual, searching through Help menus for brief memory joggers is not an efficient use of their time. For these individuals, any assistance required is minimal and should be presented as succinctly as possible. Lastly, the system may be revised, updated, or otherwise maintained by an individual at an organization remote from the user. Therefore, the user or other person responsible for system management locally must have a working understanding of the system in order to do system maintenance and limited troubleshooting. Such maintenance may be as trivial, yet necessary, as replacing data files and archiving unneeded user files. However, in order to accomplish even these small tasks, the maintainer must have knowledge of the files that comprise the system. Therefore, a system maintainer's guide would round out the external documentation provided to ARI on Product 3.

6.1.4 Conclusion

While Product 3 will use Help functions and on-line training to the greatest extent possible, it is not possible to satisfy all management and maintenance requirements solely through this method. Therefore, Product 3 on-line documentation will be supported will be further supplemented and expanded upon by two off-line products for the use of ARI only as overall system maintainer: 1) an installation guide, and 2) a system maintenance guide. It is only by the inclusion of these external references that Product 3 can fulfill its required assistance and training functions.

6.2 Glossary

6.2.1 Abbreviations/Acronyms

ADB	Alphanumeric Data Base
ANA	Analysis component
ARI	Army Research Institute
ASI	Added Skill Indicator
ARIMA	Box-Jenkins Autoregressive/Moving Average Time Series
BIOS	Basic Input Output System
DAI	Design Aid Interface component
DIF	Data Interchange Format
DMDC	Defense Manpower Data Center
DOS	Disk Operating System
EMF	Enlisted Master File
EMS	Extended Memory Standard
FMS	File Management System
GDB	Graphic Data Base component
ICD	Interface Control Drawing
ICWG	Interface Control Working Group
KAI	Knowledge Acquisition Interface component
LAN	Local Area Network
LHASH	Revelation data file
LLSC	Low Level Software Component
MANPRINT	Manpower and Personnel Integation
MOS	Military Occupational Specialty
OMF	Officer Master File
RAM	Random Access Memory
ROS	Revelation data file
SPR	Search Process Record component
TCL	Terminal Control Language
T/H	Training/Help component
TLSC	Top Level Software Component
WAN	Wide Area Network

6.2.2 Terms Glossary

Directed acyclic graph: Unidirectional graph in which no cycles occur.

Bernoulli disk: A class of removable hard disk.

Bit-mapped graphic images: A method of storing images such that each bit in stored form corresponds directly to a pixel on the screen.

Correlation coefficient: Statistical method used to measure the strength of the relationship between two variables.

Dereferencing: The process of obtaining the value of a pointer.

Dynamic memory allocation: The use of data structures that can be sized at run time rather than at compile time, enabling them to grow and shrink as a particular session requires.

EGA-based graphics: A graphics programming and display standard based on the functionality of the Enhanced Graphics Adaptor card.

Extended Memory Standard: A standardized method in the Intel 808X/802XX microprocessor family by which memory greater than 640K bytes is accessed. This standard uses memory mapping, a technique of using the directly accessible 640K of memory as a map into the higher level memory.

Linked list nodes: Data connected in memory through the use of pointer addresses dereferencing in a linear manner.

Full Screen Editor: An editor that permits the display of text on an entire screen, and has facilities for the addition, modification, and deletion of text at any place on the screen.

Nonparametric Statistical Operations: Any statistical evaluation that does not assume a distribution for the data.

Local Data: Data created and destroyed in a single software component.

Mass storage device: Method used for the nonvolatile (permanent) storage of information. Common forms are hard disks and floppy disks.

Parametric Statistical Operations: Any statistical evaluation that assumes the data follow the normal distribution.

Project A data base: A data base developed by the American Institutes for Research, under contract to ARI, that measures a large number of cognitive performance characteristics on a significant Army soldier sample over a period of time.

Redirection operator: A method of directing program inputs and outputs using other than the standard input and output devices.

Revelation: Revelation is the full-featured relational data base management system to be used in Phase 3 development.

Standard input device: The default device for input into a computer system. Normally this is the keyboard.

Standard output device: The default device for output from a computer system. Normally this is the screen display.

Taxonomy: An ordering of soldier characteristics and Army systems and conditions used in the Product 3 design search process.

Transformation: The modification of data according to an algebraic function.

Unmapped Memory: Any main memory in a computer system that is accessed directly by the processor. For an IBM PC compatible, the maximum is 640K bytes.

APPENDIX I. SYSTEM INTEGRATION GUIDELINES

Provided by Dr Jonathan Kaplan, Army Research Institute, 31 July 1987

10.1 Application

All guidelines refer to the products being developed as part of the ARI MANPRINT Methods Development Program.

10.2 Hardware

All software to be developed should be able to run on the same hardware. The hardware of choice has the following characteristics:

a. Enhanced graphics display.

b. Enhanced graphics board with 256KB RAM.

c. 80286 processor.

d. Hard disk with a minimum of 20 megabytes of storage.

e. Up to four megabytes of enhanced memory. Memory to conform to EMS standard.

f. Bernoulli Box or its functional equivalent with two removable 20 megabyte disks.

g. 80287 coprocessor chip for intensive floating point computations.

h. 1200/2400 baud internal modem that conforms to Hayes standards.

i. Floppy drive(s) capable of read/write to 360 kilobyte floppy diskettes.

j. Dot matrix printer with 132 characters per line capability. Printer must be capable of emulating IBM Graphics and Epson FX and LQ series printers.

k. Mouse and mouse drivers as required. Drivers for major brands of mice (in bus and com port configurations) should be provided.

l. An AT keyboard.

10.3 Operating Systems

All software to be developed should run under the same operating system. Until further development results in an available multitasking operating system, the DOS of choice will be DOS 3.2. Any requirement for contacting

more than 640 kilobytes of memory will be handled via the EMS standard for enhanced memory.

10.4 Product Interactions

In many cases, the output of one of the products will be used as input by another. This means that each product must be able to convert its output to a form (like ASCII) that can be understood by any other product that needs it, and some mechanism for moving such files from one machine to another must be provided. All products must have alternative mechanisms for developing and/or inputting these data. Potential product interactions are as follows:

a. Product 1 receives no input from any of the other products.

b. Product 2 receives missions from Product 1.

c. Micro Analysis & Design - DRC's Product 3 receives MOS, and maximum manning requirements across systems from Product 2.

d. Perceptronics-AIR's Product 3 receives missions, functions, tasks, conditions, and criteria from Product 1. It receives MOS from Product 2.

e. Product 4 receives functions, tasks, and criteria from Product 1.

f. Micro Analysis & Design - DRC's Product 5 receives tasks from Product 1 (as a fall back).

g. ASA-SAIC's Product 5 receives tasks from Product 1 (as a fall back).

h. Micro Analysis & Design - DRC's Product 6 receives missions, functions, tasks, jobs, number of individuals per system, task performance times, performance criteria, and task sequences from Product 5. It receives training times and gross types of training media per function/task from Product 4. It receives a measure of central tendency of each soldier characteristic from Product 3.

i. Analytics' Product 6 receives missions, functions, tasks, conditions, and criteria from Product 1.Training times and media per function/task are received from Product 4. Task times and jobs (described as groups of tasks) are received from Product 5.

j. Perceptronics-Hay's Product 6 receives missions, functions, tasks, conditions and criteria from Product 1. It receives jobs (described as groups of tasks) from Product 5.

10.5 Software

It is acceptable to use off-the-shelf software packages as components of the various products. Any such software must be available to the government through existing contracts. It is preferable to keep the number of software packages that the government must purchase to a minimum. At present, it is assumed that individual users of the various products will purchase their own off-the-shelf software packages (rather than via an ARI licensing agreement). However, the software produced for the six products will, without alteration, be able to communicate with all required off-the-shelf software.

Software and data bases will be available on Bernoulli discs. However, users will be offered the option (by software) to read from and write to the system's hard disk, if they choose not to purchase a Bernoulli. Master Bernoulli disks will be kept unused and will be copied for use. To allow relatively easy alterations of product output thus permitting sensitivity analysis and other "what if" games, intermediate files will be saved. All such intermediate and final output files will be saved to Bernoulli disk for security purposes.

If social security numbers are used in data bases that are internal to any of these products, they will be encrypted. This encryption will permit linkage to external data sources, but will prevent product users from identifying the specific individuals to whom such data is linked.

Two commercial database management systems have been selected: R-Base V, and Pick/Revelation. No additional DBMS can be included as a product if this inclusion would result in product users having to purchase a third DBMS. Writing a DBMS to serve as a component of a product is acceptable.

In addition, such a database must be capable of editing inputs from other products and must be accessible via calls from Microsoft C. All users of DBMS components in their products must provide all other teams with the software required to: open, access, and close their DBMS data/files. This software must be developed and provided no later than six months following the start of Phase III. All products will output files in delimited fixed ASCII according to Data Interchange Format (DIF) to permit data communications.

The development language of choice is Microsoft C.

A "Data Dictionary" will be developed by the various product design teams to facilitate data communications among the products. This dictionary will be completed in three months from the start of Task 2. This dictionary will have the following classes of information.

a. Field names.

b. Length per field.

c. Type per field (alpha, numeric, etc.).

d. Comment per field (description of contents).

e. "Parent-child" relationship per field (Where does it come from and where does it go in a hierarchy).

f. Range per field.

g. Name of each record.

h. Estimated numbers of records.

10.6 User Interfaces

It is critical that the user interface(s) of all the MANPRINT products be designed in a manner that makes their operation as simple and self-evident as possible. The object of these products is to aid personnel who have limited or no computer experience. Six of the ten design teams have specified their intention to develop a common interface based upon the interface of Borland's Turbo C. The following requirements apply to any interface that is to be used by any product. They are mandatory.

a. The user will not have to memorize command language.

b. Training will be handled by a "self-evident" interface and/or built in help. Whenever external training (documentation or instruction) is called for, it must be accompanied by an explanation as to why this could not be accomplished by the interface and/or help.

c. If a mouse is used, equivalent keyboard entries must be available to the user.

d. Vocabulary meaning must be consistent across all products. That is, whenever a term (condition, criterion, characteristic, etc.) is used, it must always mean the same thing in each product. An on-line glossary providing definitions of all key terms will be available as part of each product.

e. If an interface requires use of hierarchically nested menus that are more than two menus deep, a mechanism must be provided the user to show him where in the menu structure he is at any time. This mechanism must be common across all products (if used).

f. If a given product requires more total effort of its user than can be done in a continuous three hour period, then the interface must provide the following two features:

(1) A mechanism for returning to the last procedure after the system has been turned off.

(2) A mechanism for seeing which procedures have been done and which have not been done at any given time.

g. To the extent possible, natural language will be used. That is, neither computer nor psychology jargon will be used to communicate unless a given word is now in the common domain.

h. If color coding is used, it must have the same meaning across all products.

i. If function keys are used, they must have the same effects across all products if at all possible. If such commonality is impossible, another sort of communication mechanism should be considered.

j. Housekeeping procedures (starting, closing, saving, restoring, etc.) should be identical across all products from the point of view of the user.

k Users should be given the option of changing the foreground vs background colors. That is, dark letters-light background or the reverse.

l. Each product will be used more than once. Therefore, the names of the files that are generated must be able to be viewed and selected. The procedures for doing this should be as similar as possible across products (from the point of view of the user).

m. Each product must include an enhanced graphics driver, mouse drivers, and printer drivers that will operate at minimum IBM, and Epson FX and LQ series printers.

n. From the point of view of the user, all editing conventions should be the same across all products. Editing includes: entering, deleting, altering, moving, and copying text. Editing conventions include the selection of keys for moving the cursor, deleting, entering, copying, etc. Editing conventions should be as simple and self-evident as possible.

APPENDIX II. LANGUAGE SPECIFICATION

20.1 Application

This Appendix provides details on the specifications for the operating system, development languages, and applications software languages to be used in the development of Product 3. The major components of each products software system shall be:

1. Operating System;
   DOS 3.xx
   CONFIG. SYS
   ANSI.SYS
   VDISK.SYS
   FILENAME.BAT

2. System Utilities;
   ASM.COM*

3. System Applications; and,
   MSOFT_C.COM*

4. Relational Data base.
   REVELATION:
   TCL
   RBASIC

(*Generic FileHandles.)

20.2 General Description

Product 3 shall have stand alone software systems consisting of these four major software component blocks. Each of these system blocks represents an area that involves some level of software language development.

20.2.1 Operating System

Product 3 shall be fully compatible with and run under either MS-DOS 3.xx or MS-DOS 3.xx. Actual development shall be conducted using MS-DOS 3.3 since earlier versions are no longer commercially available. Beta tests

will be conducted using MS-DOS 3.2 to insure reverse compatibility[1]. The products will make full use of DOS capabilities to perform such functions as batch processing, execution of external applications software, maintenance of the native file system, I/O control and all of the other normal DOS functions. The software shall use the extended DOS environment to maintain the path, and pass link, control strings and data between the data base and external applications. The software shall configure DOS to take full advantage of the extended control offered by the ANSI.SYS. The user may optionally run the products in a system having memory that is expanded above the DOS 640 KBYTE maximum by configuring a disk cache or a simple RAMDISK, using VDISK.SYS.[2]

20.2.2. System Utilities

A variety of system utilities shall be developed in assembly language and assembled using MicroSoft's Macro Assembler, 4.0. Assembly language shall be chosen when either speed, compact code, or direct, low overhead, calls to the BIOs interrupts are a primary requirement.[3]

20.2.3. System Applications

System applications programs shall be developed using C compatible with Microsoft's C Compiler and run-time library.[4] All information outputs and Revelation data base files shall be accessible through standard Microsoft C run-time library I/O and file handling routines.

[1] IBM AT Technical Reference Manual. IBM Corp., 1985.
IBM DOS 3.1 Technical Reference Manual. IBM Corp., 1985.
IBM DOS 3.2 Manual. IBM Corp., 1986.
IBM DOS 3.2 Technical Reference Manual. IBM Corp., 1986.
IBM DOS 3.30 Manual. IBM Corp., April 1987.
IBM DOS 3.30 Technical Reference Manual. IBM Corp., April 1987.

[2] Lotus Intel Microsoft Expanded Memory Specification. Version 3.20. U.S.A.: Lotus Development Corporation, Intel Corporation, Microsoft Corporation, 1985.

[3] Microsoft Macro Assembler for the MS-DOS Operating System, Version 4.00. Microsoft Corp., 1985.
Proceedings. Memory Resident Utilities Conference, May 1986.
Microsystems Components Handbook. U.S.A.: Intel Corporation, 1985.

[4] Microsoft C Run-Time Library Reference. Microsoft Corp., 1985.

20.2.4 Relational Data Base

Product 3 shall be developed using the REVELATION relational data base software.[5] The data base languages used in the development of the product 3 relational data bases shall be Revelation Terminal Control Language (TCL) and RBASIC. Revelation provides an applications generator that parses TCL query sentences and compiles RBASIC programs. RBASIC compiled programs are structured according to the precedents of the parser, and are self documented.

The Revelation applications generator shall be used to generate the base structures for all data base programs. Each of the programs shall then be minimally customized to fit the MANPRINT products interface requirements. This use of the applications generator shall provide uniform quality assurance across programs and produce standard documentation of all of the applications programs generated across the two products. (The importance of this feature of the Product 3 programs can not be overstressed.) All of the applications programs shall be structured, programmed, and documented using identical formats. All of the programs shall share the same set of algorithms, appearing in the same locations within the source code. This will yield products that have maximal future growth and development capability.

[5] Revelation Technical Reference and User's Guide. Cosmos, Inc, 1985.

APPENDIX III. USER-SYSTEM INTERFACE DESIGN REQUIREMENTS

30.1 Background

MANPRINT User-system interface (USI) software requirements have been extracted from MIL-STD-1472C, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, Section 5.15, ESD-TR-86-278, Guidelines for Designing User Interface Software, and AFAMRL-TR-85-013, Person Computer Dialogue: A Human Engineering Data Base Supplement. Figures 30-1 through 30-5 provide illustrative operations and maintenance menu screens. To the extent possible and as available, Product 3 detailed design of USI procedures shall strive to incorporate any future USI standards that will be established for all MANPRINT products, including but not limited to viewing and selecting files, function keys, housekeeping procedures (e.g., starting, closing, saving,storing, etc.), and vocabulary meanings.

30.2 Requirements.

Product 3 USI software shall be developed in accordance with the requirements of the following sections.

30.2.1. Minimization of User Training Requirements

The USI design goal shall be to minimize the amount of time and effort required by a user to become proficient in use of Product 3 procedures. As a minimum, USI features shall comply with the following general requirements:

a. Interactive procedures including the use of function keys shall be consistent within and between all types of data entry, sequence control, display, and printing operations.

b. Operator effort shall be minimized in control and entry actions.

c. Wording of messages and displays shall be in plain English (natural language) or match MANPRINT user job-oriented vocabulary. The user shall not be required to memorize command language.

d. Abbreviations and acronyms shall be used only when they are significantly shorter than the full text and can be easily understood by a Product 3 user.

e. USI control requirements shall not require the user to memorize a command language.

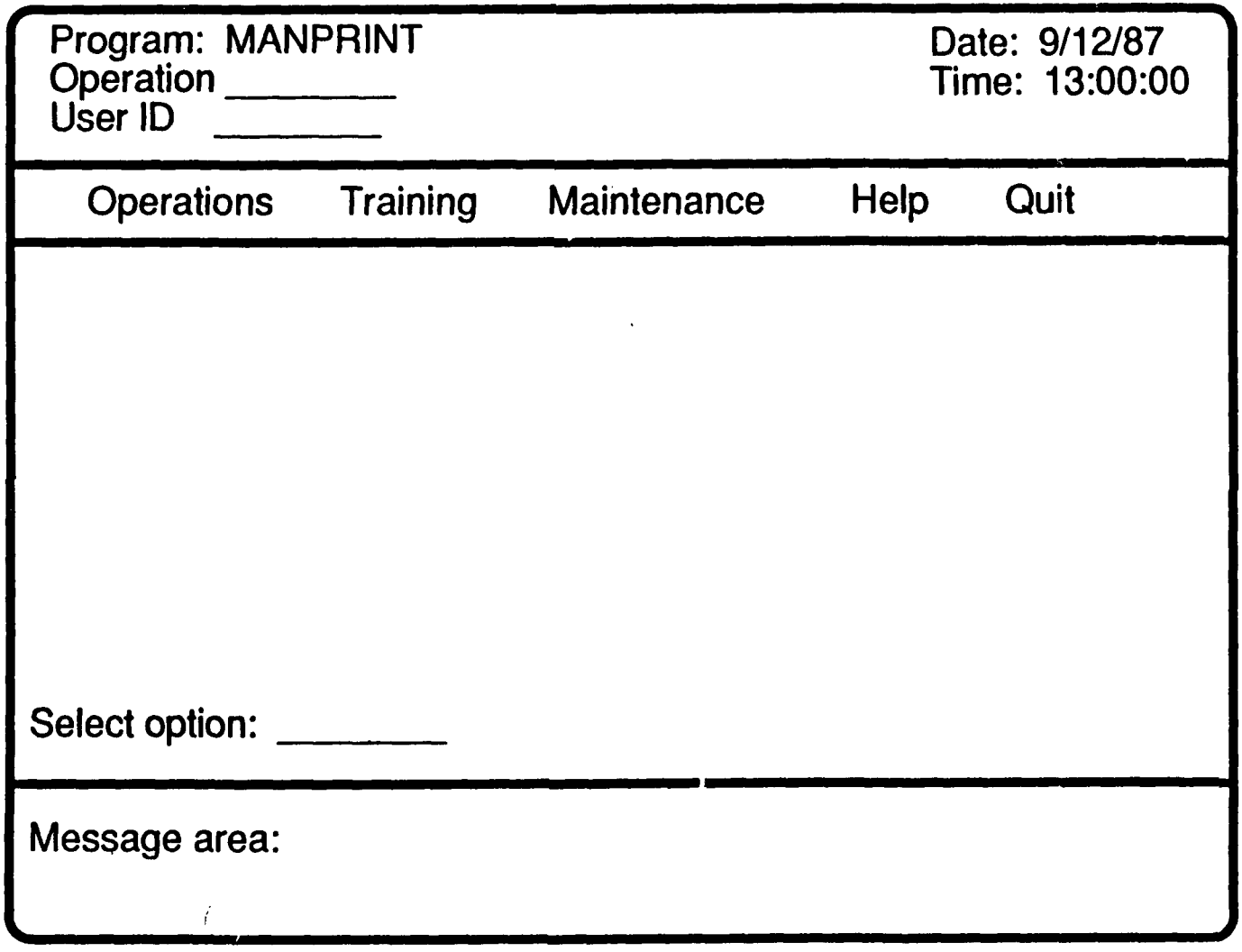


Figure 30-1. Illustrative Product 3 Main Menu

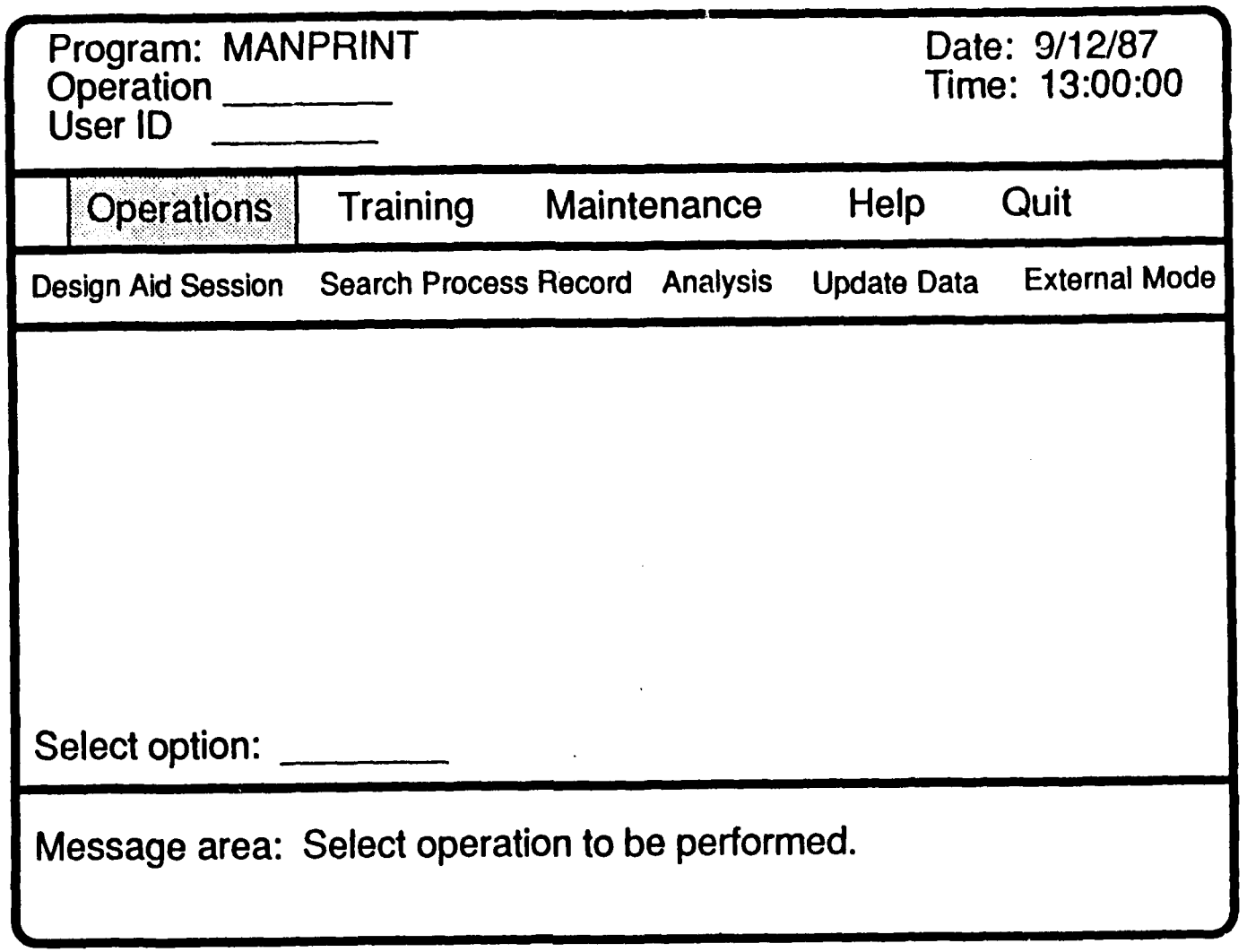


Figure 30-2. Illustrative Product 3 Second Level Menu

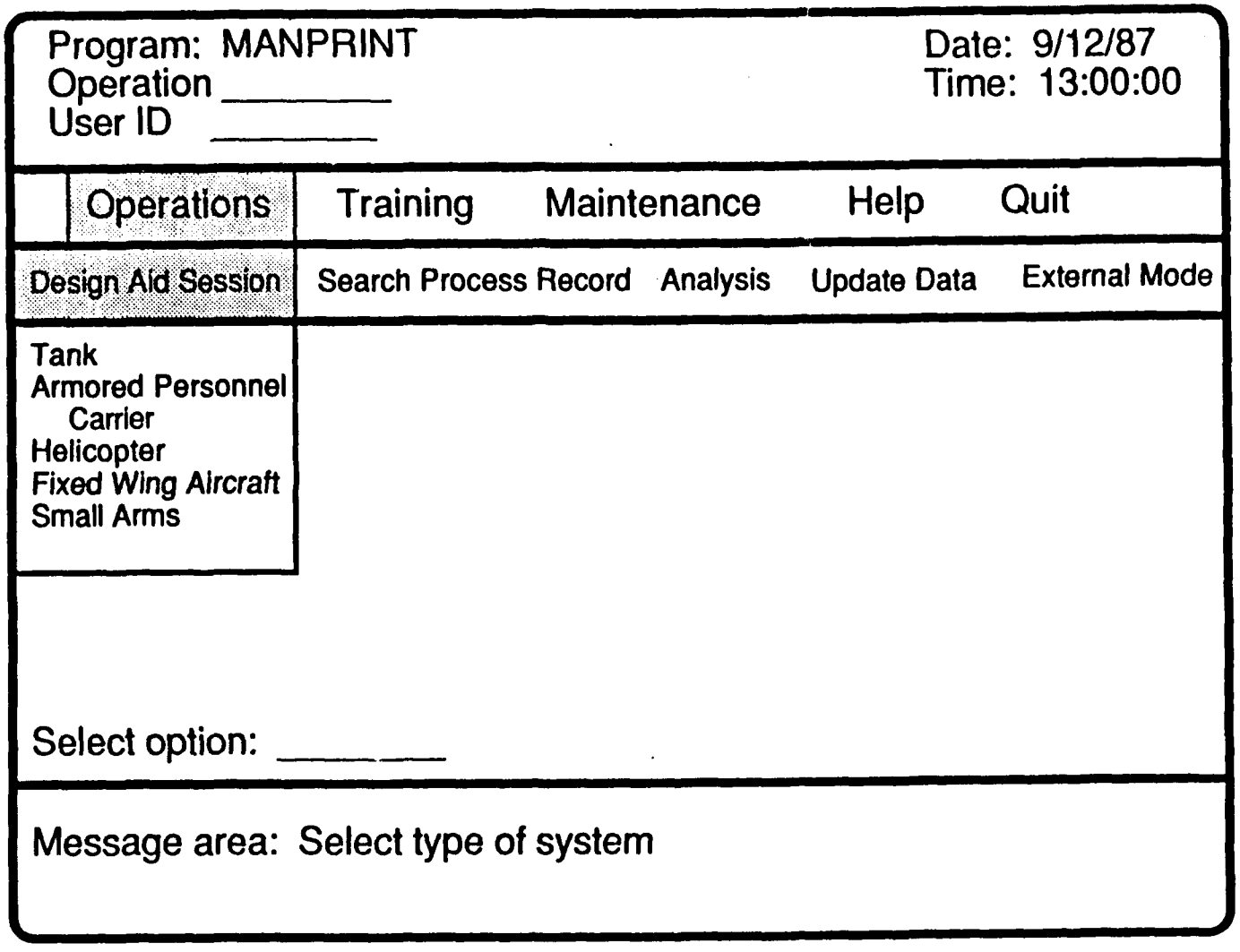


Figure 30-3. Illustrative Product 3 Third Level Menu

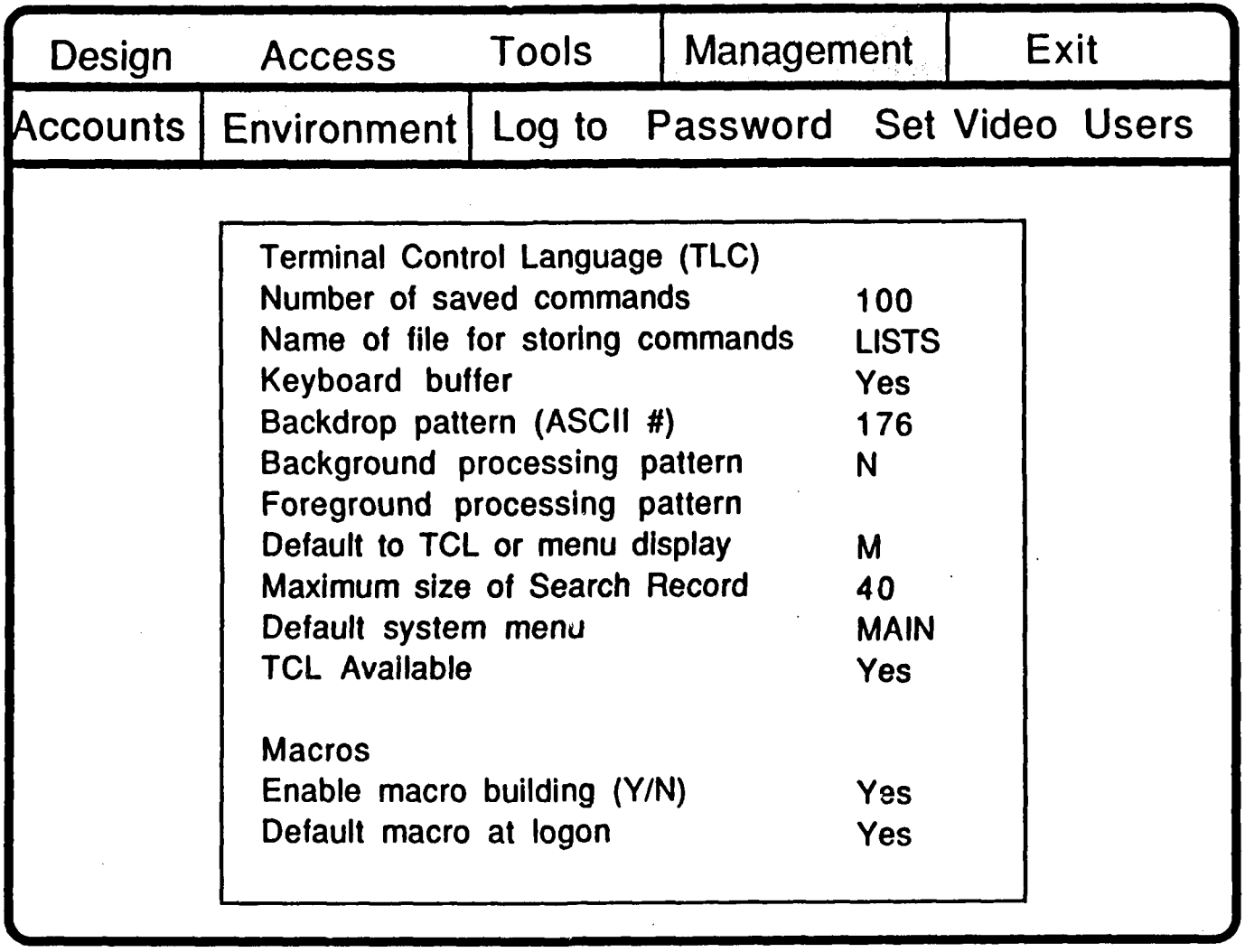


Figure 30-4. Illustrative Product 3 Maintenance Lower Level Menu - Page 1 of 2

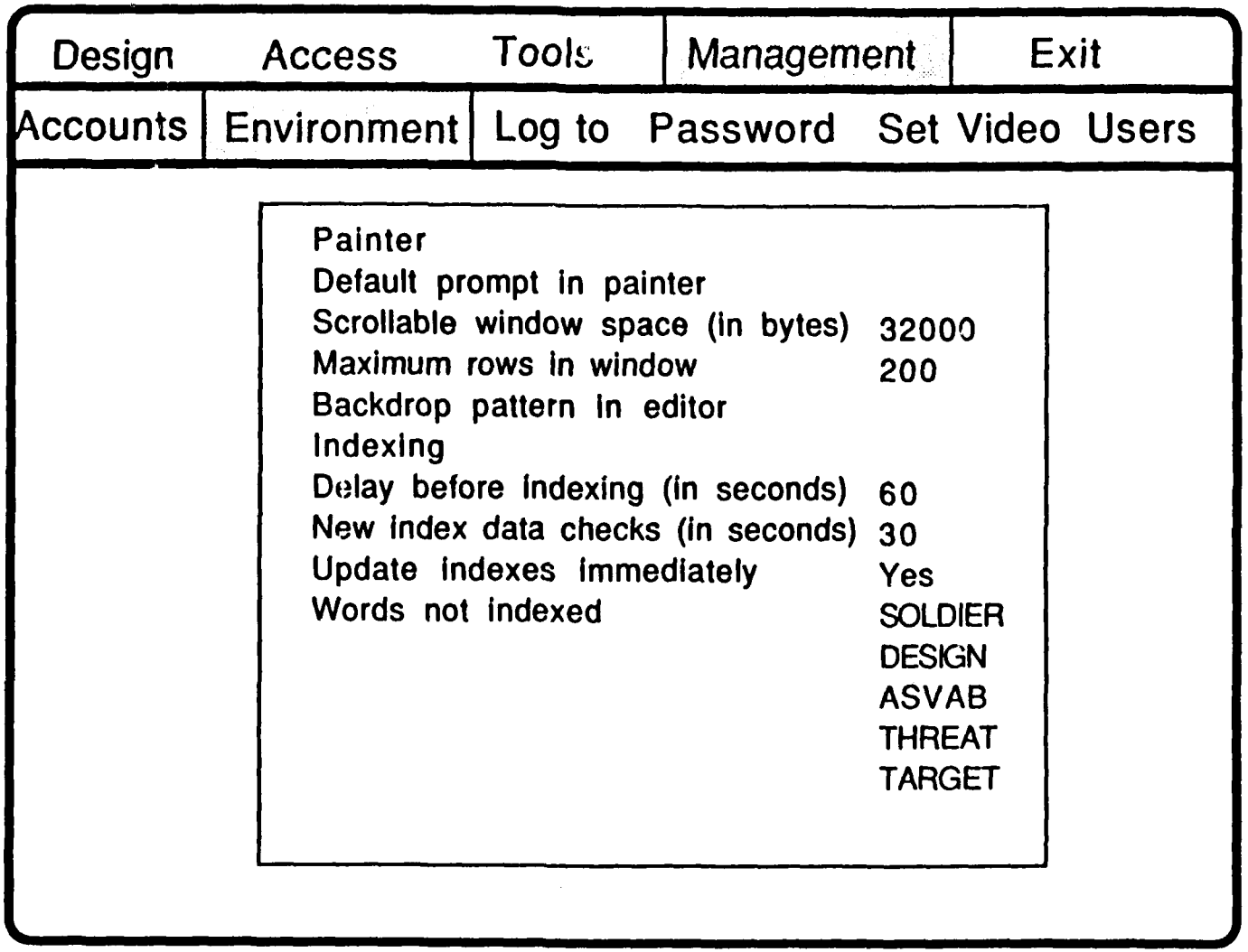


Figure 30-4. Illustrative Product 3 Maintenance Lower Level Menu - Page 2 of 2

f Users shall not be required to translate, compute, convert, interpolate or otherwise mentally manipulate data when interpreting displays or messages, or performing data input or control functions.

g. The operator shall receive positive acknowledgement of all command inputs, that are legal, valid, and have been accepted for processing. This acknowledgement shall be the immediate display of requested information or an acknowledgement message for those inputs that cause processing not visible to the user.

h. Product 3 software shall check for obvious errors. Reporting of errors shall be in accordance with the requirements in paragraphs 30.2.8 d & e. of this Appendix.

i. The user shall have the option of changing the foreground vs. the background colors of the display screens.

30.2.2 Data Entry

Product 3 data entry functions shall comply with the following requirements:

a. The user shall not be required to enter data which is already available within Product 3 software or data files.

b. Normal default values shall be provided wherever applicable to speed data entry. The user shall have an easy means to accept or change default values.

c. The user shall not be required to enter leading or trailing blanks or zeros. If data items are always preceded or followed by special characters, the characters shall be supplied by the Product 3 software.

d. For complex data inputs, prompts shall be provided to guide the user and minimize data input errors.

e. All user inputs shall be checked for validity and completeness. When feasible, erroneous inputs shall be identified and recommended alternatives shall be provided to the user.

f. Data entry screens shall be organized to minimize user search and retrieval efforts.

h. The normal position for the cursor during data entry shall be at the first location where data could be entered. Areas of the screen not needed for data entry shall be inaccessible to the user.

i. The user shall be allowed to enter data by character replacement, such as underscores or default values.

j. For complex data entry screens, the user shall be able to work on the whole data entry screen before transmitting it to the Product 3 software.

k. Editing conventions (e.g., selection of keys for moving the cursor, deleting, entering, copying, etc.) shall be as simple and self-evident as possible.

30.2.3 Data Display

Product 3 data compilation and displays of compilations shall comply with the following requirements:

a. Product 3 displays shall have a title that clearly and specifically describes their contents.

b. The home position of the cursor shall be in a consistent position across similar types of displays.

c. Similar screens shall be displayed in a consistent format.

d. The user shall automatically be presented with the top level menu immediately upon logging into the system.

30.2.4 Text Display

a. Text screens shall use mixed, upper and lower case characters with appropriate punctuation.

b. Text shall be left justified but with a ragged right margin.

30.2.5 Display of Data Tables

a. Columns and rows of tables shall have meaningful titles.

b. Items in tables shall be in a recognizable order that will facilitate user comparisons and scanning.

c. Items in multiple column tables shall be in vertical columns that are read from left to right.

d. Alphabetic data in tables shall be left justified while numeric data shall be right justified or aligned by a decimal point or other delimiter.

e. A blank line shall be inserted after about every fifth item in a long table.

f. Long strings of alphanumeric data shall be broken up into smaller groups of three to four characters.

30.2.6 Graphic Display

a. Actual data values shall be used to supplement their graphic representation when precise reading of a graphic display is required.

b. Scales shall be constructed with tick marks at a standard interval of 1,2,5,10 or multiples of 10.

c. The following guidelines shall be used for the selection of appropriate graphic display formats:

(1) Smooth curves or line graphics shall be used for displaying relations between two continuous variables.

(2) Bar graphs shall be used for comparing a single measure across a set of several entities or for a variable sampled at discrete intervals.

(3) Pictorial displays shall be used when it is necessary to show accurately detailed representations of real or imaginary objects.

30.2.7. Highlighting

a. Highlighting methods shall be selected that are appropriate for the level of importance of the information being displayed.

b. Blinking displays shall be used only to highlight critical information that requires an immediate response from the user.

30.2.8. Messages

Product 3 messages shall include prompts, help instructions, and error messages which shall comply with the following requirements:

a. Messages shall be displayed in a standard location.

b. Messages shall use plain English or MANPRINT job-oriented language.

c. Help messages shall describe procedures in logical order. Where appropriate,examples of required responses shall be provided.

d. Error messages shall be as detailed as possible to explain the cause of an error without using error codes. Whenever possible, the message shall indicate corrective action to be taken.

e. Error messages shall be neutral and not assign blame to the user or the Product 3 software.

30.2.9 Sequence Control

Product 3 sequence control procedures shall comply with the following requirements:

a. Whenever possible, Product 3 software shall use menus and function keys to control the sequence of actions. Each menu screen shall have a title at the top which describes its purpose .

b. To the greatest extent possible, menu levels shall be limited to two. If an interface requires nested menus more than two menus deep, the user shall be provided with a display to show the location of the level within the menu structure at all times.

c. Menu options shall be ordered by either their expected frequency of use or their logical sequence of operation.

d. When the menu options consist of phrases or sentences, they shall be displayed in mixed, upper and lower case letters.

e. On menu screens, the cursor shall be placed automatically in the same location on the screen, normally in the area where commands are entered.

f. Whenever possible, "Pop-up" menus shall use simple active verbs as menu options.

g. The menu levels shall be designed to show the user where he is in the structure at any time. The user shall be able to easily return to the top level menu from any menu.

h. Function keys, if applicable, shall be used to speed up the execution of frequently used or critical operations.

i. The sequence control procedures shall provide:

(1) A mechanism for returning to the last procedure after the system has been turned off, and

(2) A mechanism for returning to the last. procedure after the system has been turned off..

30.2.10. Data Security

Product 3 USI data security procedures shall comply with the following requirements:

a. When an operator action interrupts a current transaction sequence, an automatic means shall be provided to prevent data loss.

b. Automatic measures shall be provided to minimize data loss from computer failure.

c. Product 3 USI procedures shall ensure that software changes data only as a result of explicit actions by the user.

d. A confirm capability shall be provided for user confirmation of a potentially destructive action.

APPENDIX IV. DATA BASE STRUCTURE AND USER PRESENTATION

40.1 Background

This appendix will describe the data base structure, user presentation, process control, and data dictionary. The soldier characteristics data bases are major components of the MANPRINT Product 3 software system. The complete data base shall consist of textual and graphical information about human characteristics which are relevant and significant for the establishment of design constraints for the acquisition of Army systems. As a minimum, these characteristics shall be compiled from the sources and organized into the taxonomy depicted in Table 40-1. Complete evaluation and determination of the data base variables shall be completed in MANPRINT Phase III. The data base will interact with the other components of Product 3 to assist the user in producing detailed and precise requirements, and therefore, increase the likelihood that the requirements will be completely implemented in systems the Army acquires.

40.2 Design Aid Interfaces

40.2.1 Design Aid Interface Operation

The design aid interface operation is a data reduction process in which Product 3 shall eliminate those soldier characteristics which are not relevant to the user's specific needs. The design aid interface shall consist of queries, in the form of menus, from which the user will select those descriptors which relate to the system in question. An example of a relational menu query appears in Figure 40-1.

40.2.2 System Parameters

a. The reduction of soldier characteristics from the total data base shall proceed based on a predetermined mapping of the characteristics to Army system parameters. The Army system parameters selected shall be based, in part, on the MANPRINT Product 1 taxonomy of Army systems. The criteria for the selection of descriptors from the Product 1 taxonomy shall be the ability of the descriptor to discriminate among soldier characteristics (e.g., if the descriptor "tank" were selected from the list in Figure 40-1, human characteristics related to threshold altitudes and physiologic limitations related to helicopters would be eliminated from the subset of characteristics Product 3 would produce).

b. Additional system parameter descriptors shall be derived in Phase III, based on the criteria of their ability to discriminate among variables and the anticipated availability of the information at an early system acquisition phase. Detailed task data is not

SOLDIER CHARACTERISTICS	DATA SOURCES															
	Project A	AF, EMF, OMF, DMDC *	PULHES	MIL-STD-1472	Bioastronautics Data Book	Human Factors Design Handbook - Woodson	AFR 161-35	Fraser, 1968	Schowalter, 1972	Jones & Prince, 1964	ESD-TR-84-190	Dumas, 1987	Handbook of Perception of Human Performance, Vol I & II, Boff, Kaufman, & Thomas, 1986	DH 1-3	DH 2-8	MIL-HDBK-759
Cognitive	X	X				X							X			
verbal ability																
numeric ability																
spatial ability																
reasoning																
mental processing																
perceptual speed/accuracy																
Short-term memory																
mechanical comprehension																
Psychomotor	X		X													
eye-limb coordination																
movement judgement																
arm-hand steadiness																
equilibrium																
finger dexterity																
manual dexterity																
control precision																
MOS General Characteristics		X														
skill level																
pay grade/date																
enlistment date																
training																
sex																
age																
citizenship																
attrition rate																
MOS aptitude/abilities		X														
years of education																
education certification																
mental category																
AFQT % Score																
Environmental																
volume								X	X	X						
temperature				X		X										
vibration, impact				X		X										
acceleration				X		X										
illumination																
Sensory Capabilities																
hearing				X		X							X			
vision				X		X							X			
control/display				X		X							X			
user system interface				X							X	X				

Table 40-I. Matrix of Soldier Characteristics Taxonomy and Data Sources

* AF - Accession File, EMF - Enlisted Master File, OMF - Officer Master File, DMDC - Defense Manpower Data Center

SOLDIER CHARACTERISTICS	DATA SOURCES															
	Project A	AF, EMF, OMF, DMDC *	PULHES	MIL-STD-1472	Bioastronautics Data Book	Human Factors Design Handbook - Woodson	AFR 161-35	Fraser, 1966	Schowalter, 1972	Jones & Prince, 1964	ESD-TR-84-190	Dumas, 1987	Handbook of Perception of Human Performance, Vol I & II, Boff, Kaufman, & Thomas, 1986	DH 1-3	DH 2-8	MIL-HDBK-759
Human Strength			X	X		X										X
lifting/carrying																
push/pull forces																
hand dynameter																
common control operational force																
strength in relation to control																
static strength																
explosive strength																
dynamic strength																
stamina																
Anthropometric																
shirt sleeved	X			X		X										
artic gear				X											X	
NBC gear																
Ground Workspace Design				X												
Design for Maintainability				X												
Design for Remote Handling				X												
Biomedical																
noise levels				X		X	X							X		
toxicological					X									X		
radiological														X		
Life Support																
water														X	X	
food														X	X	
sleep loss/fatigue						X						X				
respiratory environmental systems				X	X	X										
Design of Equipment for Remote Handling				X												
Small Systems & Equipment				X												
Operational & Maintenance Ground/ Shipboard Vehicles				X												
Hazards and Safety				X												

Table 40-I. Matrix of Soldier Characteristics Taxonomy and Data Sources

* AF - Accession File, EMF - Enlisted Master File, OMF - Officer Master File, DMDC - Defense Manpower Data Center

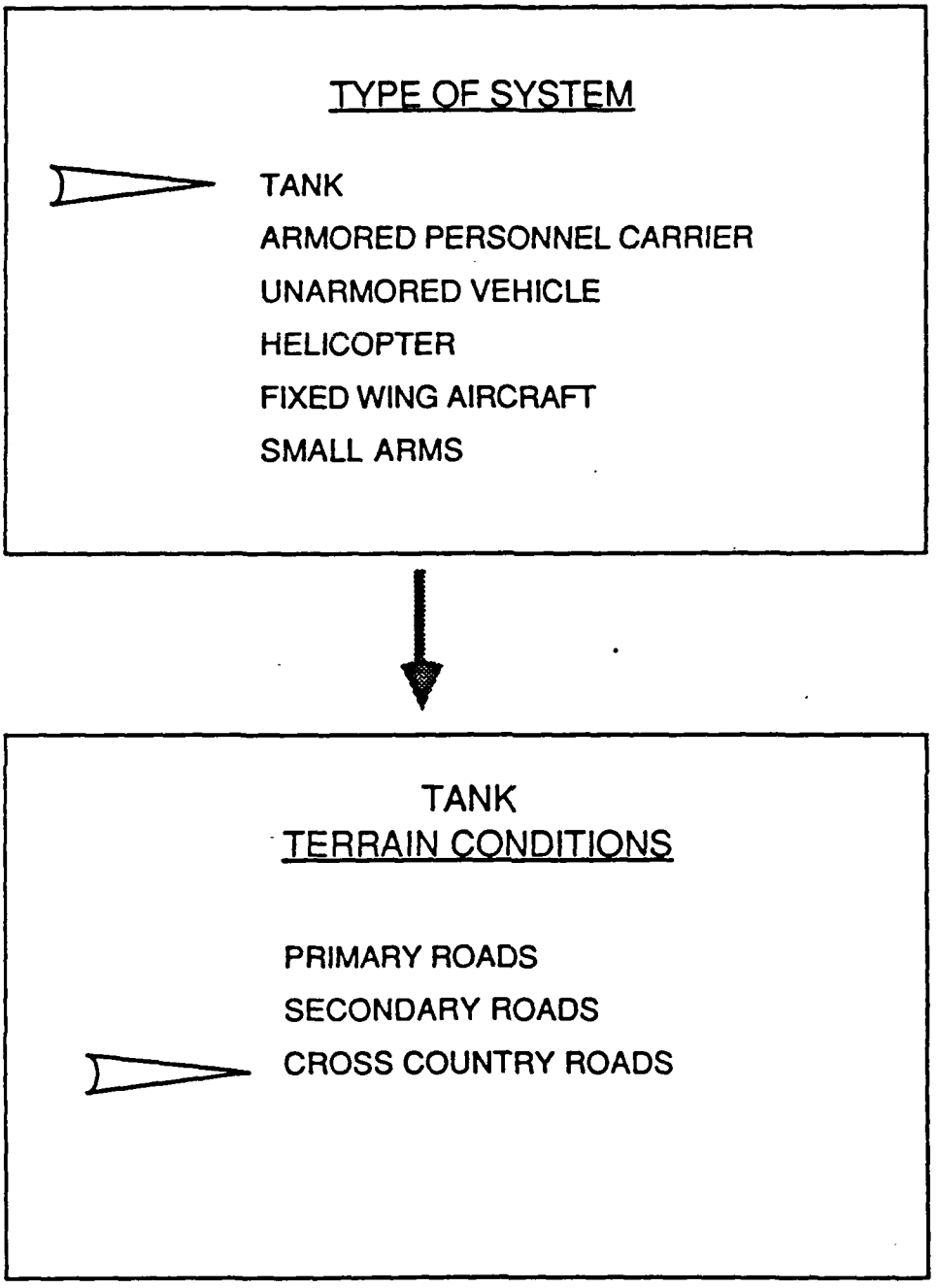


Figure 40-1. Example Relational Menu Query Text

anticipated to be known and shall therefore not be included. However, certain system parameters related to personnel may be known early (e.g., the decision for crew size: 2-man tank, 6-man tank, etc., would generally accompany early system conceptualization. Therefore, a query of crew size would be appropriate for inclusion because it influences minimum volume requirements and because the information should be available).

40.2.3 Description of Process

a. When the user begins a Product 3 design aid interface process, the entire data base shall be available. As more and more descriptors are selected which specify the system of interest to the user, the system-specific data base shall become a smaller and smaller subset of the original data base. All dialogue screens shall have a user option to continue the search without designating a specific descriptor. Multiple descriptors may also be selected from a single list, if appropriate.

b. Once initiated, the design aid dialogue shall proceed according to the responses of the user until its conclusion, unless the user chooses, at any point, to terminate the dialogue and to either:

   (1) Proceed to the point where the dialogue would end;

   (2) Return to the main menu; or

   (3) Save the partially completed dialogue until a latter time.

c. If the user selects, at any point in the dialogue, to terminate the dialogue but to proceed to its normal conclusion point, the Product 3 system shall respond as if the user had proceeded through the entire dialogue, with defaults for all queries past the termination request.

d. At the design aid dialogue conclusion point, a subset of system-specific soldier characteristics shall have been defined according to the user's inputs and the predetermined relationships between system parameters and soldier characteristics. This subset shall be made available through the menus. The top level menu will contain the major categories such as cognitive, psychomotor, etc. The user shall select a category and one or more lower level menus shall be presented according to the appropriateness of further subdividing the topic area.

e. The users shall always be able to know where they are within the data base menu structure and shall easily be able to move between menu levels and menu categories.

40.3 Data Base Manipulations

Textual and/or graphic displays shall be presented to a user after selection from the main menu (e.g.,"Environmental" and from the lower level list of "Vibration Tolerances"). For multiple displays with textual and/or graphical data, each display shall remain on the screen until the user selects an option to advance one display, go back one display, return to higher level memory, or exit. The alphanumeric data may be edited, stored, and printed on hard copy. This shall allow the user to accumulate a set of soldier characteristics, edit them as required to be appropriate for a specific use, and produce a hard copy which will be easily transferable to a design specification or RFP. Figure 40-2 presents an illustrative display example of maximum levels of human vibration tolerances. This statement could be edited by the user to be appropriate for a design specification as follows: 3.3.6.1 Vibration. The X-Tank shall be designed to impose a maximum of 6-watts of absorbed power to the crew seat.

40.4 Data Base Contents

The contents of the data base shall consist of significant soldier characteristics which are presented in a format which shall be useful for MANPRINT specialists responsible for developing Army system design constraints which relate to human performance. Table 40-2 shows the top level and second level categories of soldier characteristics presented in Table 40-1, broken out a third level where appropriate. Each broad topic area is discussed below.

40.4.1 Cognitive/Psychomotor

a. All of the cognitive dimensions and two of the psychomotor dimensions (eye-limb coordination and movement judgment) shall originate from measures within the Project A data base. Individual Project A measures shall be organized into a smaller number of relatively distinct factors, following Wing, et. al. (1985)[1]. Personality and temperament measures are omitted as these are less obviously related to the performance of specific types of tasks. The remaining measures are organized into 10 dimensions. The 10 dimensions, and specific Project A tests that measure individual differences along these dimensions, are presented in Tables 40-3 and 40-4. The Project A data will provide

[1] Wing, H. Peterson, N.G, & Hoffman, R.G. (1984, August). Expert judgements of predictor-criterion validity relationships. Paper presented at the Annual Convention of the American Psychological Association, Toronto, Canada. (In ARI Technical Report 660, July 1985; appendices in ARI Research Note 85-14, October 1984.)

Vibration Tolerances

Reaction Time

Vibration does not typically affect human reaction time. When reaction time is affected during or following vibration exposure, only several one-hundredth of a second are added to the static base reaction time, normally 0.02 to 0.05 seconds. Increases in vibration intensity or duration do not produce corresponding changes in reaction time.

Visual Impairment

Visual impairment is extremely sensitive to the specific vibration/task situation. In general, the range of 10 to 24 Hz is most detrimental to visual performance. In a supine position, a helmet can reduce visual error when motion is in the x-axis. However, significant error reduction in the z-axis results when the head can move freely. There is some indication that higher frequencies (11 and 15 Hz) in the z-axis may result in larger error when a helmet is worn. In general, tasks that measure central neural processes such as reaction time, monitoring, and pattern recognition, appear to be highly resistant to degradation during vibration.

Visual blurring occurs at 0.40 Root Mean Square (RMSq) 1-1000 Hz, for a 40 minute exposure.

Maximum Levels

Vehicles should be designed so as not to impose vibration on its occupants in excess of 6-watts of absorbed power. Beyond this level there is a risk of human injury and cargo/vehicle damage.

Figure 40-2. Alphanumeric Data Base Display Screen Text

TABLE 40-2. Soldier Characteristics: Taxonomic Structure

Cognitive	Verbal ability Numerical ability Spatial ability Reasoning Mental processing Short term memory Perceptual speed/ accuracy Mechanical comprehension	
Psychomotor	Eye-limb coordination Movement judgment Arm-hand steadiness Equilibrium Finger dexterity Manual dexterity Control precision	
MOS General Characteristics	Skill level Duty position Pay grade/date Enlistment date Training Sex Age Citizenship Attrition rate	
MOS Aptitude/Abilities	Years of education Educational certification Mental category AFQT% score	

TABLE 40-2. Soldier Characteristics: Taxonomic Structure

Sensory Capabilities	Hearing	Stimulus, thresholds Loudness, pitch, Localization Aural distortion Auditory attention Speech clarity
	Vision	Color discrimination Eye movements Light sensitivity Binocular vision Space perception adaptation Peripheral vision
	Control/display	Control/display integration Visual displays Audio displays Controls Labeling
	User system interface	Data entry Data display Interactive control Error messages Visual pattern recognition Data processing skills
Human Strength	Lifting/carrying Push/pull forces Hand dynameter strength Control operational force Static strength Explosive strength Dynamic strength	

TABLE 40-2 Soldier Characteristics: Taxonomic Structure

Anthropometric	Shirt-sleeved	Standing body dimensions Seated body dimensions Depth/breadth dimensions Circumferences/surface Hand/foot dimensions Head/face dimensions
	Arctic/NBC gear	Sizing of controls & access openings Visibility limitations Thermal stress factors
Environmental	Volume	
	Temperature	Thermal response Tolerances high/low Temp/ventilation req.
	Illumination	
	Impact	Human tolerance limits Physiological response
	Vibration	Effects on performance Physiological effects Interaction with other environmental parameters
	Sustained linear and rotary acceleration	Subjective effects Physiological effects Human tolerances Performance effects

TABLE 40-2. Soldier Characteristics: Taxonomic Structure

Biomedical	Noise	Exposure limits Effects on hearing Effects on communication Hearing protection
	Toxicological	Oxygen toxicity Fuels and oxidizers Carbon monoxide Threshold limit values
	Radiological	Radiation detection Biological effects
Life Support	Potable water	Daily requirements Thermal interactions
	Food	Nutritional requirements Preservation Mission applications
	Sleep loss/ fatigue	Continuous operations Partial sleep loss Total sleep loss Circadian cycle effects Effects on performance
	Respiratory environmental systems	Cabin pressure failure Physiologic criteria Hypoxia at high altitudes
Other detailed requirements from MIL-STD-1472	Ground workspace design	General Standing operations Seated operations Common working positions Standard console design Stairs, ladders Ingress and egress Surface colors

TABLE 40-2. Soldier Characteristics: Taxonomic Structure

Other detailed requirements from MIL-STD-1472 (cont'd)	Design for maintainability	General Mounting of items within units Adjustment controls Accessibility Lubrication Cases and cover mounting Cases Covers Access openings and covers Fasteners Unit design for efficient handling Mounting Conductors Connectors Test points Test equipment Failure indications and fuse requirements Printed circuit boards
	Design of equipment for remote handling	Characteristics of equipment to be handled remotely Manipulators Viewing equipment Illumination
	Small systems and equipment	Portability and load carrying Tracking Optical instruments and related equipment

TABLE 40-2. Soldier Characteristics: Taxonomic Structure

Other detailed requirements from MIL-STD-1472 (cont'd)	Operational and maintenance vehicles	General Seating Controls Operating instructions Visibility Heating and ventilation Trailers, vans and intervehicular connections Cranes, materials handling and construction Automotive subsystems
	Hazards and safety	General Safety labels and placards Pipe, hose, and tube line identification General workspace hazards General equipment-related hazards Platforms

Table 40-3. Cognitive Dimensions

Dimension Name	Description	Specific Measures
Verbal Ability	Ability to understand written and, in some instances, spoken language	ASVAB: paragraph comprehension ASVAB: word knowledge
Numeric Ability	Ability to perform arthimetric operations quickly and accurately	ASVAB: Math knowledge ASVAB: Arithmetic Reasoning Project A: Number memory
Spatial Ability	Ability to identify objects that have been turned or rotated, to mentally assemble or disassemble a system into consistent pieces, and to see figured progression	Project A: Assembling objects; object rotation; maze test; map test; orientation test.
Reasoning	Ability to discover rules or principles underlying relationships among objects and to apply these to solving problems	Project A: reasoning test
Mental Processing	Ability to respond quickly and accurately to information, including the ability to attend simultaneously to multiple stimuli when required	Project A: simple reaction time; choice reaction time
Short Term Memory	Ability to recall recent information and stimuli.	Project A: short term memory; number memory
Perceptual Speed and Accuracy	Ability to notice similarities and differences in visual stimuli quickly and accurately	ASVAB: coding speed Project A: perceptual speed/accuracy Project A: target identification
Mechanical Comprehension	Ability to understand mechanical operations and relationships and the knowledge of automotive, shop, and electrical machines, tools, and equipment based on mechanical principles	ASVAB: mechanical comprehension; auto/shop information electronic information

Table 40-4. Psychomotor Dimensions

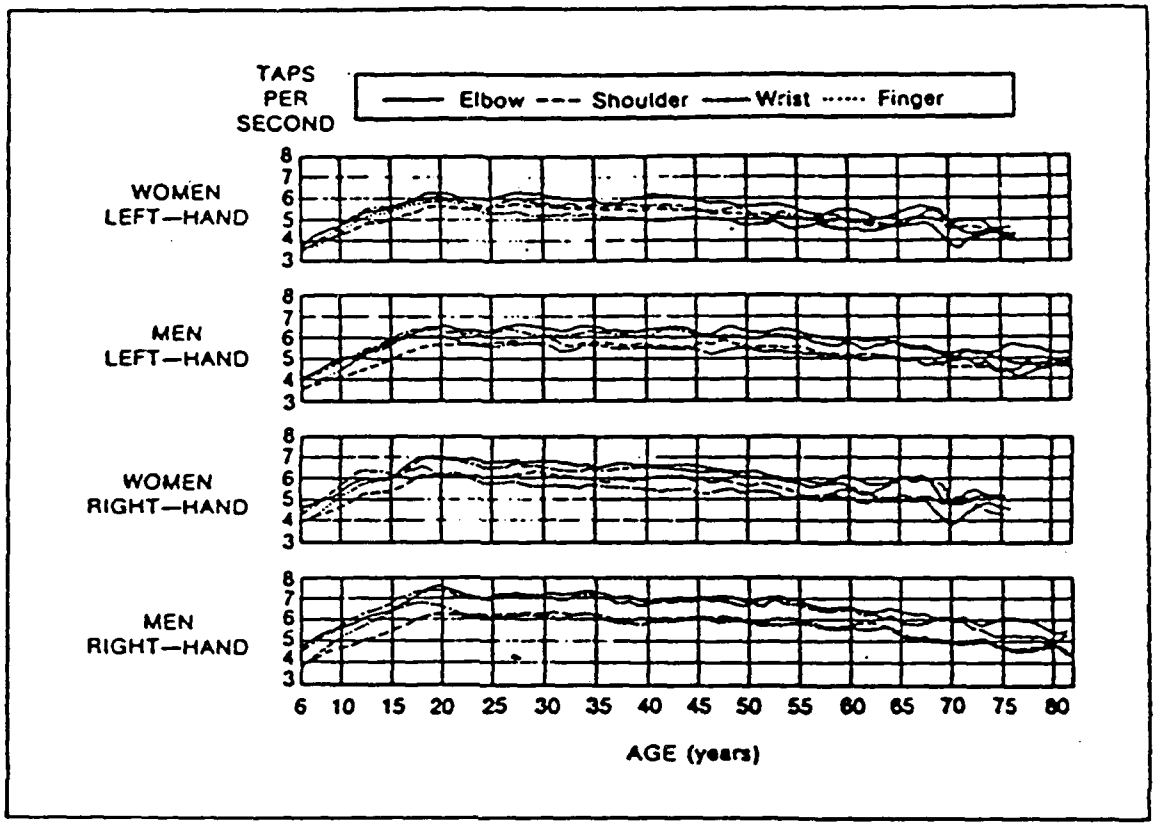
Dimension Name	Description	Specific Measures
Eye-Limb Coordination	Ability to make steady and precise hand and arm movements, particularly in response to moving targets	Project A: Target Tracking 1 and 2 Project A: Target shoot Project A: Pooled movement time
Movement Judgement	Ability to judge rates of speed and directions of moving objects and predict their location at future points in time	Project A: Cannon shoot

considerable information on variations between different kinds of military occupational specialties (MOS) in cognitive and psychomotor ability distributions. The abilities described must however, be scaled relative to task requirements. In using Product 3, it will be necessary to know both how many job incumbents possess various levels of skill and also what levels of skill are required for different types of tasks. Anchors shall be provided for the cognitive and psychomotor measures that relate otherwise abstract scales to specific task requirements (e.g., specific human tolerances for different temperature levels can be used to specify appropriate environmental limits for new systems).

b. There is also a need to specify requirements such as verbal ability levels on a scale that has meaning for MANPRINT specialists. Two approaches will be used for anchoring the cognitive and psychomotor dimensions meaningfully. First, the specific Project A measures shall be examined for marker items that convey the abilities involved. As an example, verbal ability vocabulary items will be found that are known or not known at different levels of ability. For spatial abilities, examples of the kinds of operations that examinees at different levels can or cannot perform consistently may be found. The second approach to anchoring the different cognitive and psychomotor ability dimensions will be to relate them directly to task performance. In support of Product 6 development, AIR has conducted a number of analyses of relationships between abilities and task performance. For each cognitive and psychomotor dimension, tasks will be identified that soldiers with different levels of the relevant abilities can or cannot perform correctly. MANPRINT specialists can then match new tasks to these marker tasks in order to determine potential design constraints for the new systems. The psychomotor category also includes five additional dimensions as shown in Table 40-2. The sources to develop these dimensions are identified in Table 40-1. An example of a screen from the manual dexterity category is presented in Figure 40-3.

40.4.2 MOS General Characteristics

As a minimum, this category shall be subdivided as follows: skill level, pay grade/date, enlistment date, training, sex, age, citizenship, and attrition rate. Statistics about the present MOS skill levels shall be included and these, along with MOS attrition rates, may be used to predict future percentile skills levels. The inclusion of pay grade/date information, also presented in statistical form, may be used to estimate system costs. Enlistment date and attrition rates may be used jointly to project future MOS availability. Training data shall be presented in terms of type and time. Sex, age, and citizenship data shall be presented as statistical percentages and may be used to characterize the current and projected MOS population.



Number of taps per second. Tapping rate increases with age up to about 18, remains rather constant from 18 to about 50 or 55, and then exhibits a slow decline with older ages. Tapping with the forearm about the elbow joint is fastest, followed respectively by wrist, shoulder, and finger. The right hand taps faster than the left (for right-handed people), and males tend to be slightly faster than females.

Figure 40-3. Example Manual Dexterity Data Base Display Screen

40.4.3 MOS Aptitude/Abilities

As a minimum, this category shall be subdivided as follows: years of education, education certification, mental category, and AFQT scores. All of these subcategories shall be presented as percentiles.

40.4.4 Sensory Capabilities

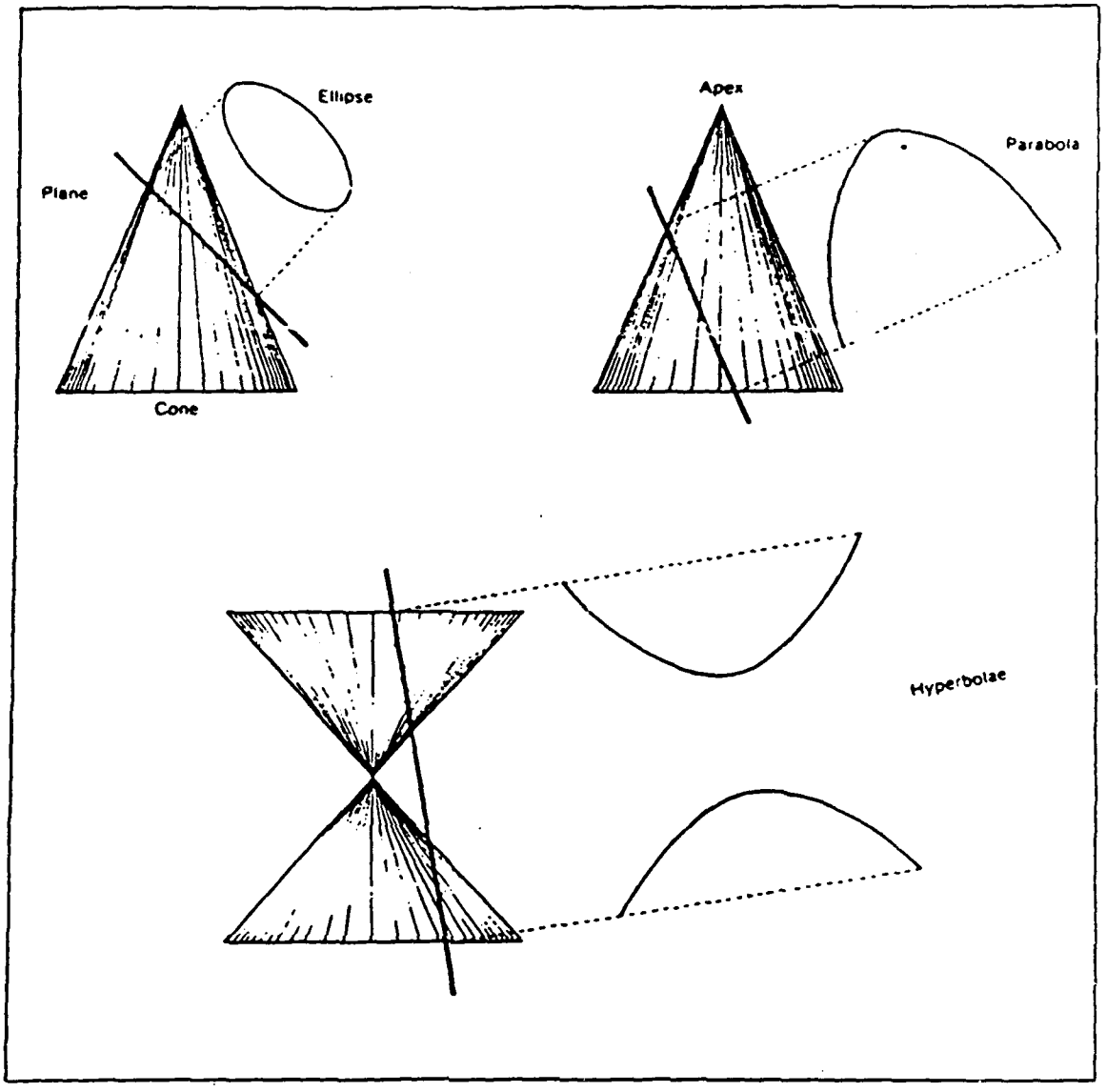
As a minimum, this category shall be subdivided as follows: hearing, vision, control/display, and user system interface. The last two categories are areas which consider both sensory and cognitive human capabilities, but are included within sensory capabilities for convenience. Figure 40-4 provides an example of a graphical entry in the data base pertaining to eye movement.

40.4.5 Human Strength

As a minimum, this category shall be subdivided as follows: lifting/carrying, push/pull forces, hand dynameter, common control operational force, strength in relation to control, static strength, explosive strength, dynamic strength, and stamina. Data for these categories shall be derived from MIL-STD-1472, the Human Factors Design Handbook by Woodson, MIL-HDBK-759, and measurements from the PULHES.

40.4.6 Anthropometric

As a minimum, this section shall be subdivided as follows: shirt-sleeved, arctic gear, and nuclear, biological, chemical (NBC) gear. The anthropometric data shall be derived from MIL-STD-1472, MIL-HDBK-759A, the Army's Accession File, and Woodson's Human Factors Design Handbook. Figure 40-5 shows two illustrative screens. The first is a menu of shirt sleeved anthropometric data. In this example, the user has selected standing body dimensions. The next screen presented would be a graphics allowing the user to select one of ten dimensions. In Figure 40-6 the user has requested standing height. Percentile values in inches shall be included for the 5th and 95th percentile ground troops, aviators, and women in accordance with MIL-STD-1472 data. In addition, MOS specific data will be provided as available. Figure 40-7 provides another screen example. In this case, the MOS dimension for elbow rest height is not available. Descriptions of the pertinence of the dimension to specific design features is provided. Additional and nonduplicative material will be used from MIL-HDBK-759A. All display screens shall display ony one dimension (e.g., waist height) per screen.



Conic sections generated by eye movements. If the eye is at the apex of a cone, the surface of the cone can be imagined to be generated by the line of sight as it tracks around a circular object. The projections of the cone on a plane have different shapes depending on the orientation of the cone and the plane. By line of sight is meant the line projecting the fovea, via the optical nodal points to the eye, to the current point of fixation.

Figure 40-4. Example Sensory Capability Data Base Display Screen - Eye Movement

TANKS - Anthropometric Data Base

Shirt Sleeved

Standing body dimensions
Seated body dimensions
Depth and breadth
Circumferences and surfaces
Hand and foot
Head and face

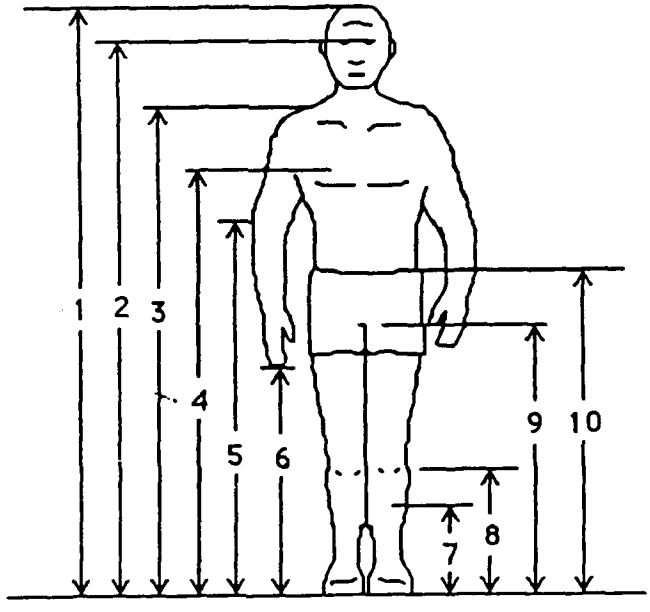
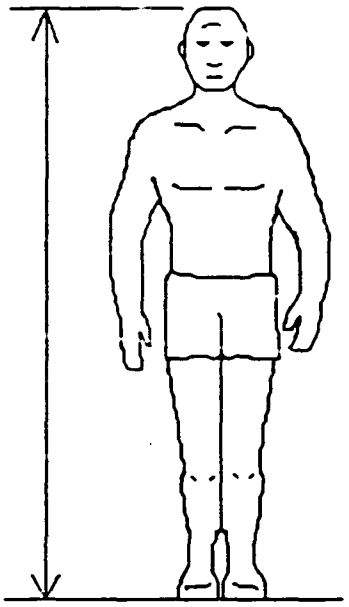


Figure 40-5. Example Relational Menu Query Screens - Shirt Sleeved Dimensions

Anthropometric Data Base
Standing Height



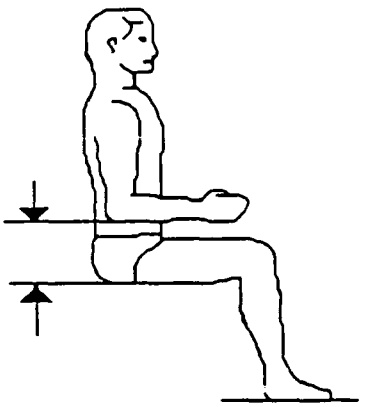
This dimension is pertinent for adjusting head clearances

Percentile values in inches

Ground Troops	Aviators	Women	MOS 11B	
64.1	64.6	60.0	64.5	5th
73.1	73.9	68.5	74.2	95th

Figure 40-6. Example Anthropometric Data Base Display Screen - Standing Height

Anthropometric Data Base
Elbow Rest Height



This dimension is pertinent to the establishment of armrest heights. Also provides a basis for establishing the level of writing surfaces and/or the approximate position of the middle row for a keyboard, the location of a joystick, handle, control wheel, etc.

Percentile values in inches

Ground Troops	Aviators	Women	
6.9	7.4	6.4	5th
11.0	11.6	10.6	95th

Figure 40-7. Example Anthropometric Data Base Display Screen - Elbow Rest Height

40.4.7 Environmental

As a minimum, this category shall be subdivided as follows: volume, temperature, illumination, impact, vibration, and sustained linear/rotary acceleration. Two examples from this section are illustrated: accelerations and volume.

a. The data base section on acceleration will be introduced to the user with a graphics of the coordinate system for accelerations influencing humans. A sample of this graphic is presented in Figure 40-8. Textual data presented in table format will be included as presented in Figures 40-9 and 40-10.

b. Crew volume requirements, also an element of environmental within the human characteristics taxonomy, shall include a table of minimum volumes related to three moderator variables: crew size, duration of confinement, and the presence of aggravating conditions such as heat or motion as illustrated in Figure 40-11. This example includes only one volume requirement. Deriving data to complete the table will be a Phase III task.Users may access this table directly, or if they have entered the appropriate information during the design aid interface process, Product 3 will generate the specific requirement (e.g., if the user was interested in a tank with a crew size of 2, no aggravating conditions, and confinement of 48 hours. Product 3 will not present the table. Instead it will present the user with the following statement: A two-person crew expected to be confined for up to 48 hours should have a minimum free volume of 125 cu. ft. per person assuming there are no aggravating conditions such as heat or motion).

40.4.8 Biomedical

As a minimum, this category shall be subdivided as follows: noise levels, toxicological, and radiological. The sources for data in these areas will be MIL-STD-1472, Bioastronautics Data Book, the Human Factors Design Handbook by Woodson, AFR 161-35, and AFSC Design Handbook DH 1-3, Human Factors Engineering. The data shall be organized by content, as opposed to the data source, and shall consist of textual and graphical data.

40.4.9 Life Support

As a minimum, this category shall include data on potable water requirements, food requirements, and the effects of sleep loss and fatigue. The sources for the information on sleep loss and fatigue shall be derived from various texts and journal research as identified in Table 40-11. The majority of the data on sleep loss and fatigue shall be textual and require multiple screens. An example of the data which shall be included in the data base for the area of sleep loss is presented in Figure 40-12.

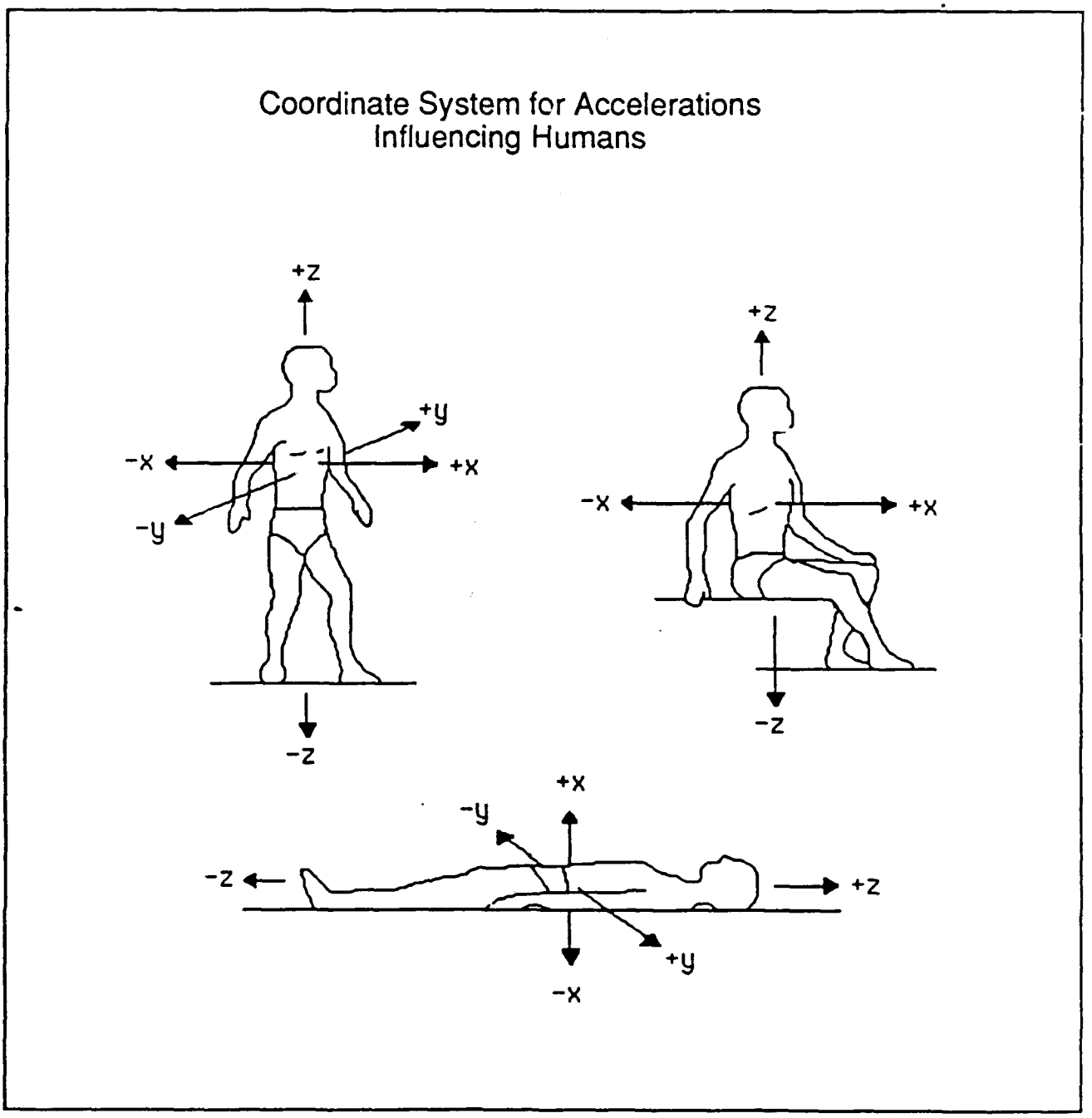


Figure 40-8. Example Data Base Display Screen for Coordinate System for Accelerations Influencing Humans

Sustained Linear Acceleration The fundamental stimulus influencing the physiological effects of sustained acceleration arises form the effective increase in weight of the body, and particularly its fluid components, along the acceleration vector.	
	Positive Acceleration Effects (+Gz)
1 G_z	Equivalent to the erect or seated terrestrial position.
2 G_z	Increase in weight, increased pressure on buttocks, drooping of face and soft body tissue.
2 1/2 G_z	Difficult to raise oneself.
3-4 G_z	Impossible to raise oneself, difficult to raise arms and legs, movement at right angles impossible; progressive dimming of vision after 3 to 4 seconds, progressing to tunnel vision.
4 1/2-6 G_z	Diminution of vision, progression to blackout after about 5 seconds; hearing and then consciousness lost if exposure continued; mild to severe convulsions in about 50 percent of subjects during or following unconsciousness, frequently with bizarre dreams; occasionally paresthesias, confused states, and rarely, gustatory sensations; inspiration difficult; loss of orientation for time and space up to 15 seconds past acceleration.
	Negative Acceleration Effects (-Gz)
1 G_z	Unpleasant but tolerable facial suffusion and congestion.
-2 to -3 G_z	Severe facial congestion, throbbing headache; progressive blurring, graying, or occasionally reddening of vision after 5 seconds; congestion disappears slowly, may leave petechial hemorrhages, edematous eyelids.
-5 G_z	Five seconds, limit of tolerance, rarely reached by most subjects.

Figure 40-9. Example Data Base Display Screen for Sustained Positive and Negative Acceleration Effects

	Forward Acceleration Effects (+Gx)
2 - 3 G_x	Increased weight and abdominal pressure; progressive slight difficulty in focusing and slight spatial disorientation, each subsiding with experience; 2 G_x tolerable at least 24 hours, 4 G_x up to at least 60 minutes.
3 - 6 G_x	Progressive tightness in chest (6 G_x, 5 minutes), chest pain, loss of peripheral vision, difficulty in breathing and speaking, blurring of vision, effort required to maintain focus.
6 - 9 G_x	Increased chest pain and pressure; breathing difficult, with shallow respiration from position of nearly full inspiration; further reduction in peripheral vision, increased blurring, occasional tunneling, great concentration to maintain focus; occasional lacrimation; body, legs, and arms cannot be lifted at 8 G_x; head cannot be lifted at 9 G_x.
9 - 12 G_x	Breathing difficulty severe; increased chest pain; marked fatigue; loss of peripheral vision, diminution of central acuity, lacrimation.
15 G_x	Extreme difficulty in breathing and speaking; severe vise-like chest pain; loss of tactile sensation; recurrent complete loss of vision.

Figure 40-10. Example Data Base Display Screen for Sustained Forward Acceleration Effects

Crew Volume Requirements Table			
Duration of Confinement	Crew Size	*Aggravating Condition	Min. cu. ft. per person
12 hours	2	yes	TBS**
		no	TBS
	4	yes	TBS
		no	TBS
	6	yes	TBS
		no	TBS
48 hours	2	yes	TBS
		no	125
	4	yes	TBS
		no	TBS
	6	yes	TBS
		no	TBS
1 Week	2	yes	TBS
		no	TBS
	4	yes	TBS
		no	TBS
	6	yes	TBS
		no	TBS
2 Weeks	2	yes	TBS
		no	TBS
	4	yes	TBS
		no	TBS
	6	yes	TBS
		no	TBS

* heat, motion, etc.
** To Be Supplied

Figure 40-11. Example Data Base Display Screen Text for Crew Volume Requirements

Sleep Loss Effects on Performance

Type of Tasks

1. Activities that demand a high level of alertness of complex perceptual/motor activity, such as moving surveillance and some driving tasks, are the most sensitive to the adverse effects of sleep loss.

2. Work-paced tasks (e.g., those whose pace is driven by the work) such as watching a radar screen, monitoring radio communications, or receiving instructions, are more subject to the effects of sleep loss than self-paced tasks.

3. Sleep deficit effects will be more apparent on newly acquired skills.

Motivation

In general, high motivation can reduce the effects of sleep loss. Although, in cases of extremely high stress, such as life-threatening situations, performance of most people will deteriorate drastically.

Personality Factors

There is evidence that introverts can tolerate loss of sleep better than extroverts. Performance on a pursuit tracking task after 60 hours without sleep has been predicted by scores on the Barron Ego Strength Scale.

Diurnal Cycle

Sleep deprivation's deleterious effect on performance is particularly detrimental between the hours of 0300 and 0600.

Task Duration

There is a noticeable decrease in the ability to focus on a task for more than a brief period. Dividing attention between two or more tasks becomes difficult.

Work/Rest Cycles

Minimum

A work schedule consisting of 4 hours on and 4 hours off has been found to be capable of sustaining minimum vigilance and cognitive performance for continuous combat.

Recommended

The recommended work/rest cycle is 6 hours on and 6 hours off.

Recovery

Upon awakening, it takes 1 1/2 hours to return to a cognitively normal state.

Figure 40-12. Alphanumeric Data Base Example of Sleep Loss Related Soldier Characteristics

40.5 Other Data Base Features

40.5.1 Glossary

The Product 3 soldier characteristic data bases shall contain a glossary of soldier characteristic data terms. Glossary terms appearing in display screens shall be highlighted. The user shall be able to move the cursor to the highlighted term and execute an appropriate command. For example, the expression "absorbed power" in Figure 40-13 would be highlighted. When requested, the definition would automatically appear within a pop-up window as shown.

40.5.2 Reference Table

Every entity in the data base (i.e.; textual paragraphs graphics, tables, etc.) shall have an accompanying identifier. Using the cursor key, a user may move to the identifier and execute an appropriate command. The source reference for the entity shall then appear automatically in the same pop-up window as that used for term definitions.

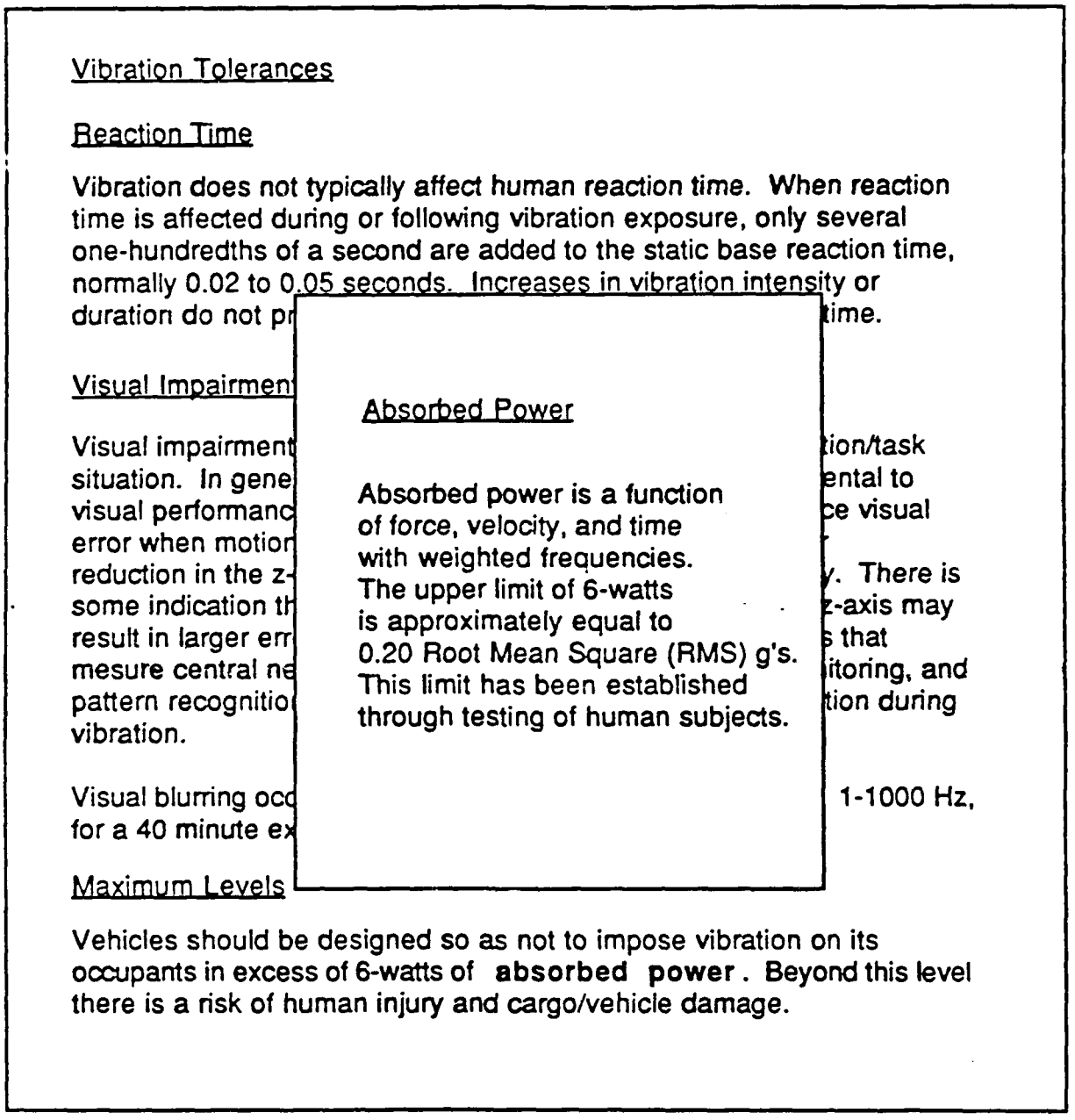


Figure 40-13. Example of Executed Data Base Glossary Display Screen

APPENDIX V. DATA BASE DESIGN SPECIFICATION

50.1 Overview of the REVELATION Data Base Environment

Characteristics of the Product 3 data base shall be compatible with the REVELATION data base management system. Figure 50.1 shows the flexible structure of the REVELATION data base management system. The REVELATION data base management system shall provide the capability to organize information about soldier characteristics into accounts, files, and records. Preliminary estimates of storage requirements for all data base records, dictionary files, and program files comprising the REVELATION system (and external files including essential MS-DOS and software tools to be stored in the initial configuration of the Product 3 data base) are listed in Table 50-1.

50.1.1 REVELATION Data Base Management System

a. REVELATION is a dictionary-driven system. Dictionaries defining all elements of accounts, files, records, and data fields in the data base (and elements of menus, windows, and help messages defining user-friendly interfaces) will also be stored in the data base. The system dictionary shall specify names of object code and source code files written in the Revelation R/BASIC language (a full-featured extension of standard Basic compatible with data base management and multi-user network operations). Names of source code files and object code files in Revelation's Terminal Command Language (using compact commands to provide short cuts for sophisticated users, bypassing menu and prompt windows) shall be stored in the data base.

b. To the host computer's MS-DOS operating system, Product 3 REVELATION files will look like any other application that builds and maintains disk files. REVELATION will be transparent to the underlying operating system which actually manages physical transfers of data between internal memory and external disks. REVELATION will ride on top of the MS-DOS operating system, maintaining its own native operating environment, including its own logical file names for dictionary files, data files, and application program files.

c. REVELATION shall interface with MS-DOS to maintain its own files and to store and retrieve external object code files. External code files (e.g. routines in MicroSoft "C" and assembly language and off-shelf or newly-built programs to construct "on-the-fly" graphic diagrams, etc.) can be called directly from within REVELATION to control special functions or hardware interfaces (e.g., mouse, page scanner, graphic digitizer, etc.).

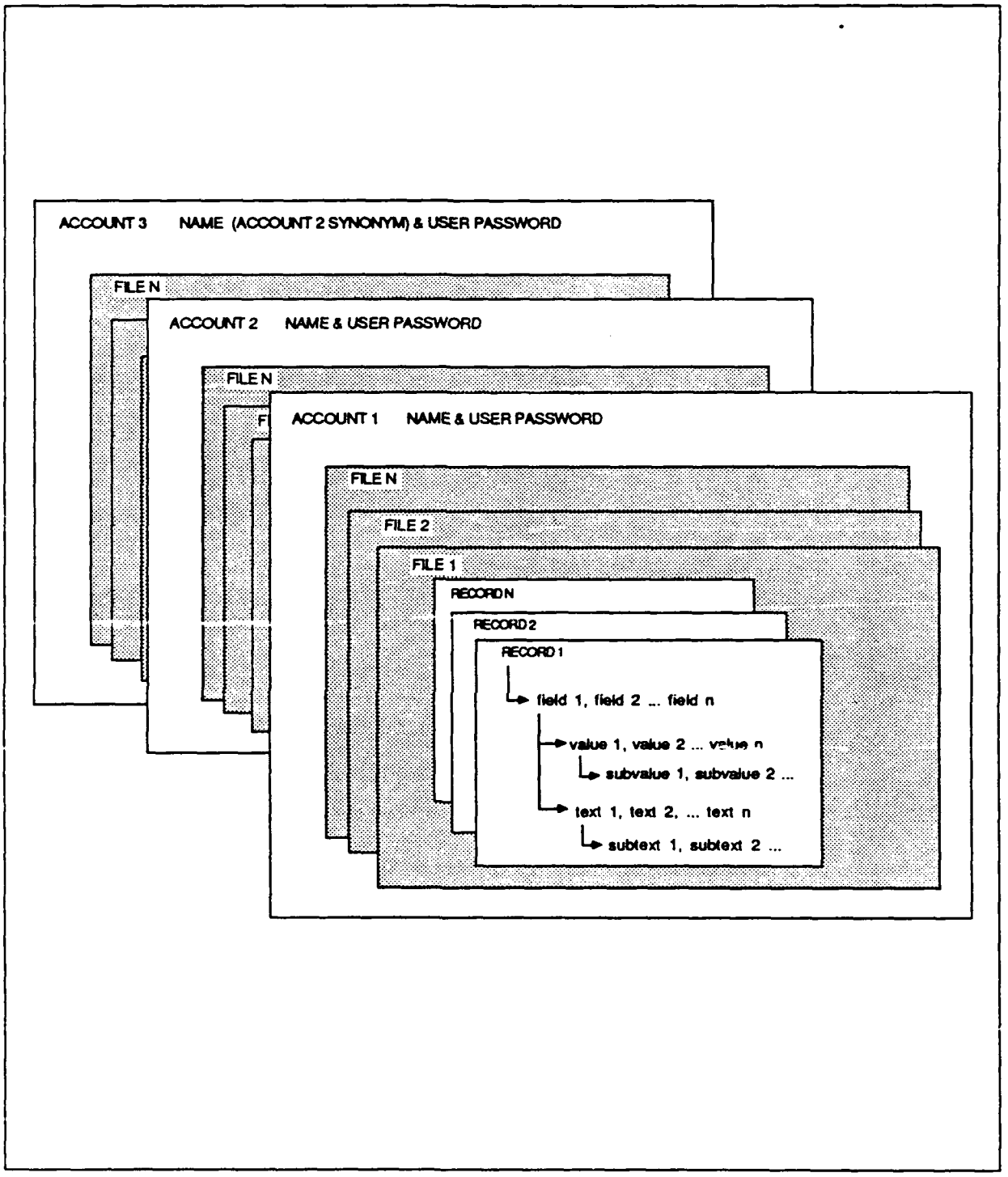


Figure 50-1: REVELATION DBMS Environment

Table 50-1: Product 3 Data Base Storage Estimates

Type of Data Base File		Megabytes
REVELATION System and MS-DOS Files		2.650
Product 3 Program Files:		.310
DAI Object Code	100 Kb	
KAI Object Code	35 Kb	
SPR Object Code	25 Kb	
Training/Help Object Code	40 Kb	
Analysis Object Code	110 Kb	
Product 3 Bit-Mapped Graphics Files (400 pics)		3.200
Product 3 Soldier Characteristics Files		2.125
(See Attached Tables)		
* Product 3 Source Code Files (8 x Object Code)		2,480
* MicroSoft C and 80286 Assembler		1.975
ESTIMATED TOTAL DISK STORAGE		12.740

* Note: Source, C, and Assembler files could be stored off-line on removable cartridge.

50.1.2 Data Base User Accounts

a. Each REVELATION account shall contain its own list of files, its own data dictionary defining names of files, records, and fields, and a set of files defining a user-friendly environment consisting of menus, pop-up windows, and associated context-sensitive HELP messages to prompt and guide the user in data selection and report formatting. Each account can have several synonymous names, and each name can have its own unique LOG-ON password. Passwords shall prevent unauthorized access to data or to potentially destructive file maintenance programs. They can be encrypted if desired and changed periodically to maintain data base security.

b. Because most users will use the same files but some system files will be used only by the system manager for file maintenance, it is anticipated that at each MANPRINT Product 3 site two or more accounts may be established, each with its own unique password. One account may be for the local system manager responsible for periodic file maintenance and coordination of import/export file processing to receive from or send files to other MANPRINT decision aid systems (e.g., Product 6). Other password-controlled accounts may be set up for local users. Users may all use the same password and same account. Account name synonyms could simply be the user surnames, or some other identification of the person, local branch office, etc. If needed, separate accounts and passwords may be set up for specialized users who do not want or need access to all files. As no TEMPEST requirements have been specified for the Product 3 host hardware system, it is not expected that any data base files will contain classified information. Creation of new accounts and passwords shall be a simple menu-driven procedure with its own built-in prompts, easily accomplished within a few minutes by an authorized user or local system manager.

50.1.3 Data Base File Management Systems

a. REVELATION supports two types of files. Changing an existing file from one type to the other shall be easily accomplished with a simple command REMAKEFILE, so design decisions are reversible. The only penalty for changing file type is the time to reformat the file and its associated data dictionary. Choice of file type shall be determined by how the files will be used, how their records will be indexed, and whether the files will be shared by simultaneous users in a local area network. The two types of internal files which can be maintained with REVELATION'S two file management systems are ROS files and LHASH files. Both

types of files shall provide for an unlimited number of variable length records with a nominal maximum of 32,000 fields per record. ROS files shall require estimates of file size, but those estimates will not limit growth of the file beyond the estimated size. LHASH files shall not require entry of estimated file sizes. Both types of files shall have the capability to grow up to the limits set by the physical capacity of the disk storage media. Both of the associated file management systems shall interface with MS-DOS in a manner which is transparent to the user. Users shall not have to be trained to become familiar with the MS-DOS command language.

50.1.3.1 ROS Files

This type file will be for use at a single-user terminal where files are NOT shared. Maximum file size is nominally 5 Megabytes, but access is slow and inefficient for ROS files over two Kilobytes because record retrieval time grows with file size. ROS file access is most efficient for files under 50 Kilobytes. ROS files shall be employed for small internal work files created or deleted by software components when and if ROS files provide faster response to user inputs and the functions being performed do not need the dynamic cache and file size management provided for LHASH files as described below.

50.1.3.2 LHASH Files

a This type file is maintained by using the "linear hashing" technique, proven to be highly efficient because access time is independent of file size. LHASH files can be shared by local area network (LAN) users, employing a record LOCK/UNLOCK semaphore system to prevent two users from trying to access or modify the same record. For local or wide area networks using packet technology, data frame size is adjustable over the range 256 to 10,240 bytes, with a default of 1,024 bytes (1 Kilobyte). At single-user terminals, small data frame sizes will make it easier to find and fix minor data entry errors in dictionary, data, or output report files.

b. The LHASH file management system is superior to the ROS file management system in several other ways which make it the best choice for most MANPRINT Product 3 data base files. LHASH file size can be automatically expanded or contracted when groups of records are added or deleted. This dynamic file size adjustment shall prevent system crashes of the type which can occur in systems using fixed record sizes for files and overflow record buffers or a variety of intermediate index files. When necessary or desirable, dynamic file size adjustment may be restricted or disabled for static files subject to little or no change in size (i.e.,

data dictionary files, which normally would expand or contract only when new fields are added or obsolete data fields are deleted from the definition of a record).

c. On a single-user terminal, the LHASH file management system shall have the capability to maintain a dynamic cache of up to 64 Kilobytes containing up to 20 data record "slots." The actual size of record slots in the cache (and the number of records storable in the cache) shall be adjusted dynamically based on the variable size of the largest record in a group. The cache and hash techniques will minimize record access time and requirements for periodic sorting and re-indexing of large files, which otherwise would consume significant amounts of time and disk space. Where applicable, alternate indexing schemes may be applied to a single file (e.g. cross-referencing, binary tree search, etc.)

d. Because of its higher efficiency, the LHASH file management system shall be used for most Product 3 dictionary and data base files and all output files built in response to user commands (e.g. output of the Search Process Record component).

e. Networking is not presently required for Product 3 single-user applications. However, the proven compatibility of the REVELATION LHASH file management system with a variety of network protocols (IBM token ring, 3MCOM ETHERNET, etc.) will leave open a door to possible future growth. Network protocols permit several terminals to share simultaneous access to a single data base on the host system hard disk. For example, simultaneous users could be two or more Product 3 users and a Product 6 user needing access to files not duplicated within the Product 6 environment, or some other combination of users connected to the Product 3 host system in a hard-wired LAN (or via telephone data links and modems in a wide-area network (WAN) with or without packet switching). If LAN/WAN operation can be shown to enhance overall efficiency and economy in operation and maintenance of the six MANPRINT decision aids, formation of an Interface Control Working Group (ICWG) to coordinate hardware and software interfaces and develop Interface Control Drawings (ICDs) would be required early in Phase III.

50.1.4 Data Base Record and Field Structures

a. The primary data structures for records stored in the MANPRINT Product 3 data base shall be open-ended dynamic arrays, as illustrated in Figure 50-2. In the REVELATION data base management system environment, all records shall be stored in a dynamic array as a string of ASCII characters punctuated with

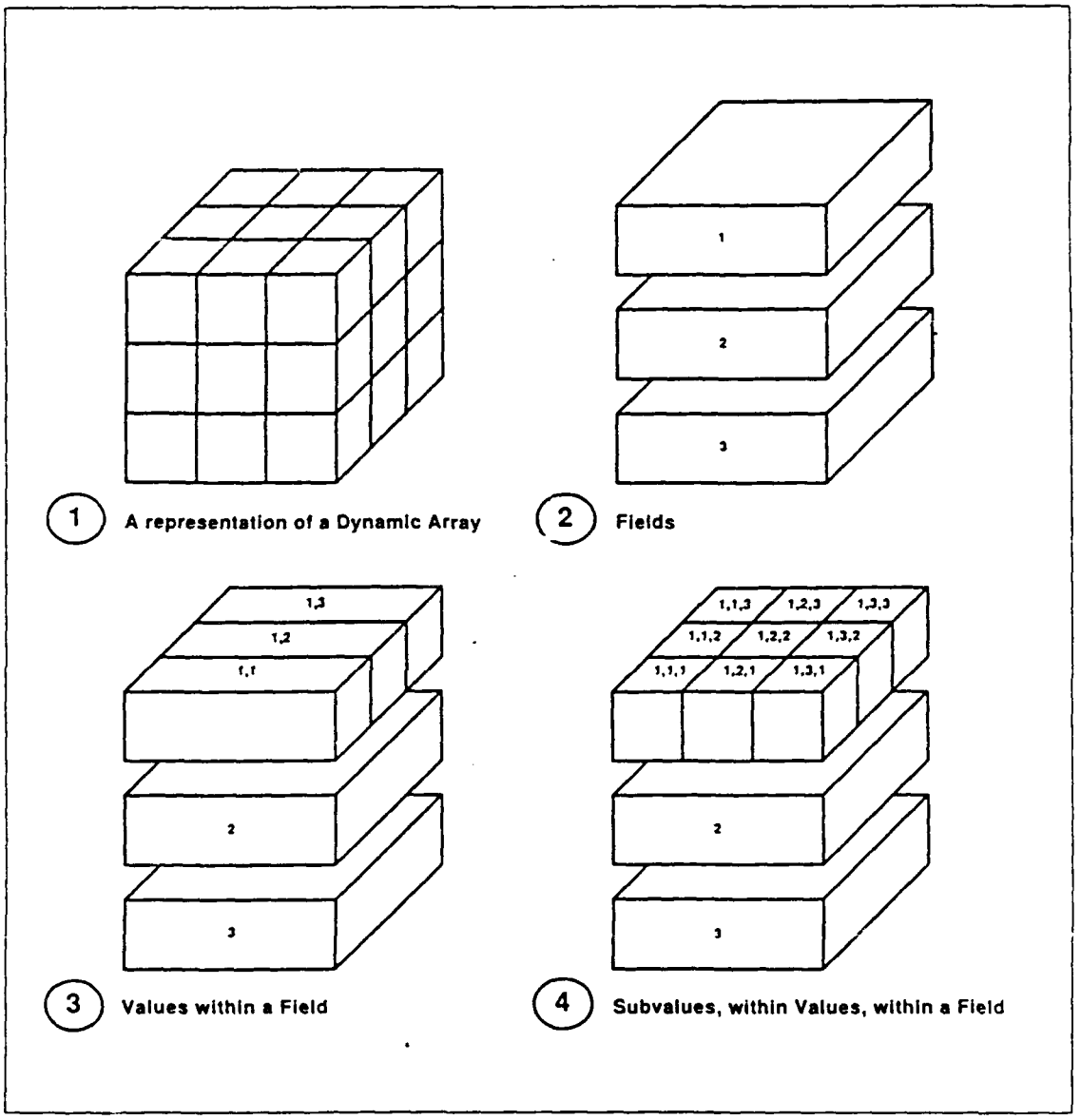


Figure 50-2: Dynamic Array Structure

delimiters. A delimiter shall mark the end of each data element in a dynamic array in a fashion similar to punctuation marks in English sentences (comma at the end of a dependent phrase, semi-colon at the end of an independent clause, and period at the end of sentence). The five types of delimiters to be used in REVELATION's dynamic array structure are listed below with their printed symbols and non-printing ASCII codes:

DELIMITER	SYMBOL	ASCII
Field Mark	@FM	254
Value Mark	@VM	253
Sub-Value Mark	@SVM	252
Text Mark	@TM	251
Sub-Text Mark	@STM	250

b. The maximum size of a record in a REVELATION dynamic array shall be 64 kilobytes, including delimiters. Each field within a record shall be separated by a field mark. Fields may contain multiple values (e.g., three types of military weapon systems maintained by personnel with a single MOS). Thus, a single record may represent a variety of one to many (master/detail or header/trailer) relations and many to one (predecessor/successor) relations. The first field in a record shall always be the key to that record, but it too can be multi-valued, thus providing secondary indexes to the same record. Secondary indexes will provide a flexible method for cross-indexing data in separate files without creation and maintenance of intermediate cross-index files. This will not preclude use of small cross-reference text files with a common key to simplify maintenance of acronyms, abbreviations and technical terms some users may not know, as illustrated in the preliminary set of data files listed in Section 50.3 below.

c. Within a multi-valued numeric field, each value shall be delimited by a value mark. In a logical field with single or multiple numeric values, sub-values will be entered which sum to a total equal to the value (e.g., in a dynamic array of demographic characteristics of soldiers, one field might contain two values, one for the number of soldiers whose native language is English and another for soldiers whose native language is not English. For the latter, sub-values could be entered for the numbers of soldiers whose native language is Spanish, Korean, or other non-English language). All sub-values will be delimited with a sub- value mark.

d. An alphabetic text string in a single field may also be divided into sub-fields using text mark and sub-text mark delimiters, permitting access to either the whole text string or two or more portions of the text string. This feature shall to be used to access keywords in titles of weapon system functions and tasks for which performance measures exist or become available.

The flexibility of REVELATION's dynamic record structures will be highly suitable for the Product 3 data base, where names and values for measures of physical and cognitive characteristics of sub-populations of soldiers (and performance measures for groups of tasks under a variety of conditions) may not be known initially, but can easily be inserted when they become available.

50.2 User Menus and Windows

a. The new (August, 1987) version of the REVELATION data base management system produced by COSMOS is significantly different from the version used to build a Product 3 prototype demonstration during the Phase I effort. In contrast to the older version of REVELATION, which relied on harder-to-learn Terminal Control Language (TCL) statements, the Advanced REVELATION DBMS software package provides a user-friendly face. Existing off-the-shelf software provides a well-defined set of over 100 easy-to-use menus, popup windows, and context-sensitive HELP messages for functions routinely performed with any data base system (display, list, report, browse, etc.). The tree structure of Advanced REVELATION menus is illustrated in Figure 50-3.

b. Most users of Product 3 will follow the main branch labelled "ACCESS" in Figure 50-3, accessing the soldier characteristics data base via menus and popup windows to select information to be included in reports. The Design Aid Interface component described in the body of the Product 3 specification shall interface with the underlying REVELATION data base dictionary of accounts, files, and record structures to provide a set of customized access paths and display, list, and report generation functions. The Design Aid Interface component shall also provide a customized set of paths to the EXIT branch to assure an orderly termination of a user session.

c. At each user site, a local user designated as the site's user account manager will follow the MANAGEMENT branch shown on Figure 50-3 to set up or delete a password-controlled account for each user. Sophisticated users may occasionally use the TOOLS branch illustrated in Figure 50-3 for import/export of templates and data sets stored in personal work files compatible with other IBM/PC software packages (Lotus 1-2-3, dBase III, etc.). The ARI

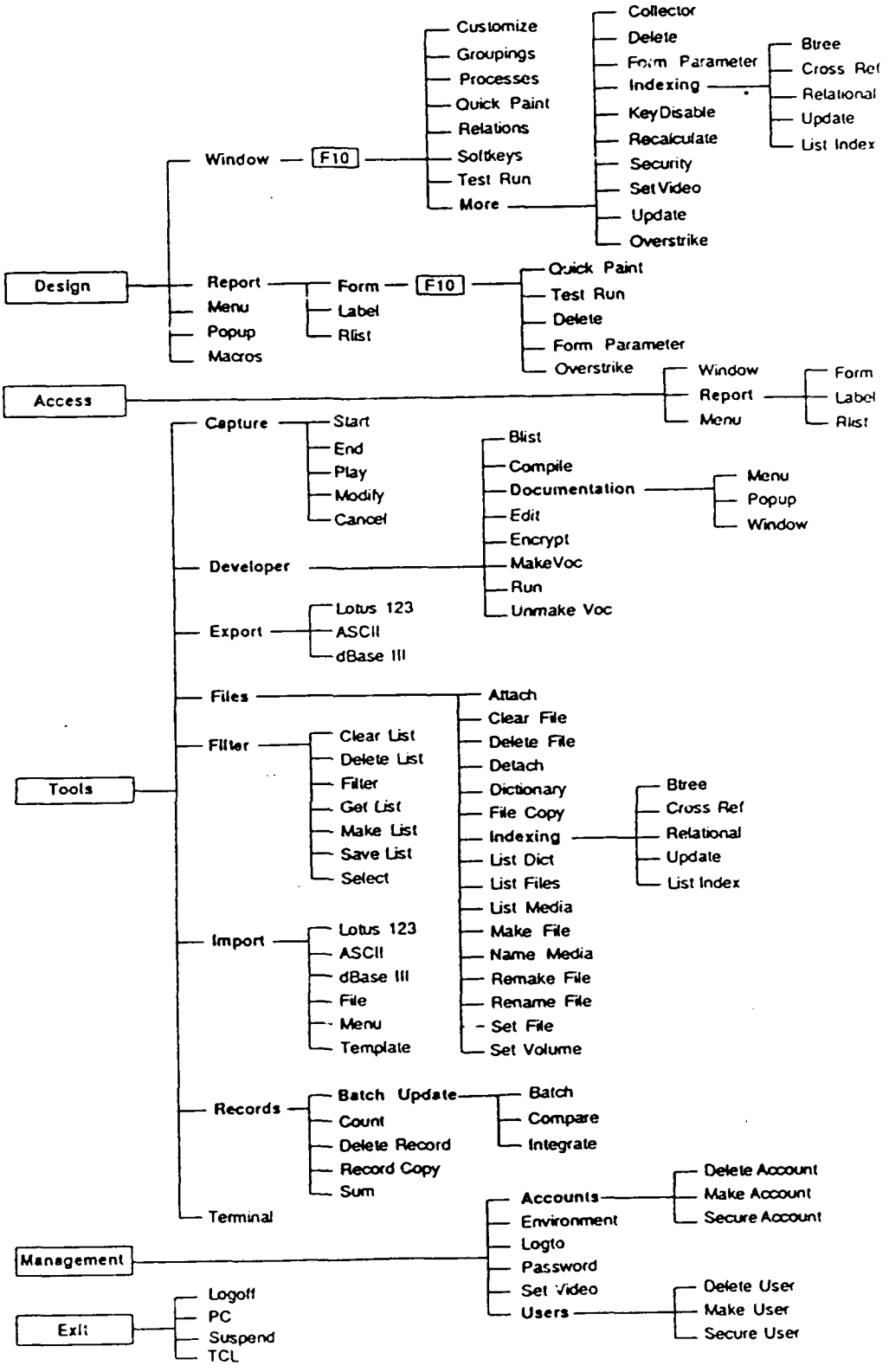


Figure 50-3: Advanced REVELATION Menu Structure

system manager and each site's user account manager will periodically use the TOOLS branch for system maintenance functions. Use of some of the potentially destructive functions on the TOOLS list and all of the functions on the DESIGN menus branch shown in Figure 50-3 can be restricted to ARI staff members (MANPRINT system manager, programmers, or research staff members familiar with system capabilities and procedures for data base maintenance and modification).

d. For users unfamiliar with use of a mouse control, the Advanced REVELATION system shall provide a thoroughly debugged set of menu select and sequence control functions using cursor keys and function keys. Product 3 applications software will include a mouse handler (compatible with the IBM/PC Microsoft Mouse Driver interface specification) and user-friendly features compatible with the REVELATION system. Product 3 mouse applications software developed in Phase III shall minimize keystrokes required from the user. Knowledgeable, trained users and system programmers familiar with TCL command syntax shall always have the option to enter and execute keyboard commands, bypassing the protection and help available by using menus and windows. Where built-in TCL error messages are judged inadequate, system-level alert messages shall be created in Phase III to prohibit or warn a user attempting to command an irreversible action (e.g. DELETE an essential system data file or dictionary file).

50.3 Preliminary Design of Data Base File/Record/Field Structures

Tables 50-2 through 50-12 provide preliminary designs for essential data files showing record structure and the descriptive dictionary name, size, type, and comments for each data field. Notes indicate the purpose of each file and source(s) of data. Test data sets will be generated from the Project A data base at AIR's Washington office, constructed by AIR's Bedford Systems Division from human engineering standards, specifications, and research documents, or derived from the Army Accession and Enlisted Personnel files available at the Army Research Institute MANPRINT program office.

Table 50-2. Main Soldier Populations File

(One Record for all MOSs, each CMF, each PMOS3 code, each PMOS5 code
(and one record for each PMOS5 + Additional Skill Identifier and
(where applicable 1-character flag * = males only/prefix or suffix

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS+ASI	8	1	8	C	Record Key
2	Population Size	6	1	6	N	Number Holding MOS
3	Males, Females	2	2	4	N	% of Population
4	Age Group	2	12	24	N	% in 3-Year Groups
5	Years of Service	2	12	24	N	% in 3-Year Groups
6	Pay Grade	2	14	20	N	% in each Pay Grade
7	Racial Group	2	6	12	N	% in each Race Group
8	Ethnic Group	2	22	44	N	% in each Category
9	Years of School	2	12	24	N	% in each Category
10	Educ.Certificate	2	16	32	N	% in each Category
11	College Major	2	32	64	N	% in each Category
12	Citizenship	2	5	10	N	% in each Category
13	Weight Lift	2	7	14	N	% in each Category
14	Physical Category	2	6	12	N	% in each Category
15	Physical Stamina	2	4	8	N	% in each Category
16	Upper Extremities	2	3	6	N	% in each Category
17	Lower Extremities	2	3	6	N	% in each Category
18	Hearing	2	4	8	N	% in each Category
19	Eyesight	2	2	4	N	% in each Category
20	S Senses	2	3	6	N	% in each Category
21	Native Language	2	2	4		% English/Other
22	Enlistment Term	2	7	14	N	% in each Category
23	Army Service Type	2	5	10	N	% in each Category
24	AFQT Category	2	9	18	N	% in each Category
25	AFQT Score	2	10	20	N	% in each Decile
26	Clerical Aptitude	2	10	20	N	% in each Decile
27	Combat Aptitude	2	10	20	N	% in each Decile
28	Elect.Aptitude	2	10	20	N	% in each Decile
29	Fld.Art.Aptitude	2	10	20	N	% in each Decile
30	GenMaint.Aptitude	2	10	20	N	% in each Decile
31	Gen.Tech.Aptitude	2	10	20	N	% in each Decile
32	Mech. Aptitude	2	10	20	N	% in each Decile
33	FoodSvc Aptitude	2	10	20	N	% in each Decile
34	PMOS SQT Score	2	10	20	N	% in each Decile
35	SurvComm.Aptitude	2	10	20	N	% in each Decile
36	Tech.Aptitude	2	10	20	N	% in each Decile

Record Size= 622
Number of Records= 1000
Est. File Size= 622,000

Table 50-2.1. Project A Soldier Task Performance "CV" File

(One Record all MOS, one record nine MOS in CV Subpopulation)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	5	1	5	C	Record Key
2	Population Size	6	1	6	N	Number Holding MOS
3	Males, Females	2	2	4	N	% of Population
4	Age Group	2	12	24	N	% in 3-Year Groups
5	Years of Service	2	12	24	N	% in 3-Year Groups
6	Pay Grade	2	14	20	N	% in each Pay Grade
7	Racial Group	2	6	12	N	% in each Race Group
8	Ethnic Group	2	22	44	N	% in each Category
9	Years of School	2	12	24	N	% in each Category
10	Educ.Certificate	2	16	32	N	% in each Category
11	College Major	2	32	64	N	% in each Category
12	Citizenship	2	5	10	N	% in each Category
13	Weight Lift	2	7	14	N	% in each Category
14	Physical Category	2	6	12	N	% in each Category
15	Physical Stamina	2	4	8	N	% in each Category
16	Upper Extremities	2	3	6	N	% in each Category
17	Lower Extremities	2	3	6	N	% in each Category
18	Hearing	2	4	8	N	% in each Category
19	Eyesight	2	2	4	N	% in each Category
20	S Senses	2	3	6	N	% in each Category
21	Native Language	2	2	4		% English/Other
22	Enlistment Term	2	7	14	N	% in each Category
23	Army Service Type	2	5	10	N	% in each Category
24	AFQT Category	2	9	18	N	% in each Category
25	AFQT Score	2	10	20	N	% in each Decile
26	Clerical Aptitude	2	10	20	N	% in each Decile
27	Combat Aptitude	2	10	20	N	% in each Decile
28	Elect.Aptitude	2	10	20	N	% in each Decile
29	Fld.Art.Aptitude	2	10	20	N	% in each Decile
30	GenMaint.Aptitude	2	10	20	N	% in each Decile
31	Gen.Tech.Aptitude	2	10	20	N	% in each Decile
32	Mech. Aptitude	2	10	20	N	% in each Decile
33	FoodSvc Aptitude	2	10	20	N	% in each Decile
34	PMOS SQT Score	2	10	20	N	% in each Decile
35	SurvComm.Aptitude	2	10	20	N	% in each Decile
36	Tech.Aptitude	2	10	20	N	% in each Decile
----------	Project A Constructs for MANPRINT Product 3	---------				
37	A:Verbal Ability	2	10	20	N	% in each Decile
38	A:Numeric Ability	2	10	20	N	% in each Decile
39	A:Spatial Ability	2	10	20	N	% in each Decile
40	A:Reasoning Abil.	2	10	20	N	% in each Decile
41	A:Ment.Processing	2	10	20	N	% in each Decile
42	A:ShortTermMemory	2	10	20	N	% in each Decile
43	A:Percept.Speed	2	10	20	N	% in each Decile
44	A:Mech.Comprehen.	2	10	20	N	% in each Decile
45	A:Eye-Limb Coord.	2	10	20	N	% in each Decile
46	A:MovementJudgmt.	2	10	20	N	% in each Decile

Record Size-	819
Number of Records-	10
Est. File Size-	8,190

Table 50-2.1.1. Project A Soldier Task Performance "CV" File

(One Record all MOS, one record nine MOS in CV Subpopulation)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	8	1	8	C	Record Key
2	A:Task-1 Score	2	10	20	N	% in each Category
...	...		...	...	...	
18	A:Task-18 Score	2	10	20	N	% in each Category
19	Last Change Date	8		D		YY/MM/DD Format

Record Size- 348
Number of Records- 10
Est. File Size- 3,480

Table 50-2.1.2: Project A Soldier Task Identification "CV" File

(One Record all MOS, one record nine MOS in CV Subpopulation)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	8	1	8	C	Record Key
2	A:Task Number	2	17	34	N	CV Task Field Number
3	A:Description	500	17	3500	C	Behavior/Procedure

Record Size- 3,542
Number of Records- 10
Est. File Size- 35,420

Table 50-2.2. Project A Soldier Sub-Population "LV" File

(One Record all MOS, one record nine MOS in LV Subpopulation)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	5	1	5	C	Record Key
2	Population Size	6	1	6	N	Number Holding MOS
3	Males, Females	2	2	4	N	% of Population
4	Age Group	2	12	24	N	% in 3-Year Groups
5	Years of Service	2	12	24	N	% in 3-Year Groups
6	Pay Grade	2	14	28	N	% in each Pay Grade
7	Racial Group	2	6	12	N	% in each Race Group
8	Ethnic Group	2	22	44	N	% in each Category
9	Years of School	2	12	24	N	% in each Category
10	Educ.Certificate	2	16	32	N	% in each Category
11	College Major	2	32	64	N	% in each Category
12	Citizenship	2	5	10	N	% in each Category
13	Weight Lift	2	7	14	N	% in each Category
14	Physical Category	2	6	12	N	% in each Category
15	Physical Stamina	2	4	8	N	% in each Category
16	Upper Extremities	2	3	6	N	% in each Category
17	Lower Extremities	2	3	6	N	% in each Category
18	Hearing	2	4	8	N	% in each Category
19	Eyesight	2	2	4	N	% in each Category
20	S Senses	2	3	6	N	% in each Category
21	Native Language	2	2	4	C	% English/Other
22	Enlistment Term	2	7	14	N	% in each Category
23	Army Service Type	2	5	10	N	% in each Category
24	AFQT Category	2	9	18	N	% in each Category
25	AFQT Score	2	10	20	N	% in each Decile
26	Clerical Aptitude	2	10	20	N	% in each Decile
27	Combat Aptitude	2	10	20	N	% in each Decile
28	Elect.Aptitude	2	10	20	N	% in each Decile
29	Fld.Art.Aptitude	2	10	20	N	% in each Decile
30	GenMaint.Aptitude	2	10	20	N	% in each Decile
31	Gen.Tech.Aptitude	2	10	20	N	% in each Decile
32	Mech. Aptitude	2	10	20	N	% in each Decile
33	FoodSvc Aptitude	2	10	20	N	% in each Decile
34	PMOS SQT Score	2	10	20	N	% in each Decile
35	SurvComm.Aptitude	2	10	20	N	% in each Decile
36	Tech.Aptitude	2	10	20	N	% in each Decile
---------Project A Constructs for MANPRINT Product 3---------						
37	A:Verbal Ability	2	10	20	N	% in each Decile
38	A:Numeric Ability	2	10	20	N	% in each Decile
39	A:Spatial Ability	2	10	20	N	% in each Decile
40	A:Reasoning Abil.	2	10	20	N	% in each Decile
41	A:Ment.Processing	2	10	20	N	% in each Decile
42	A:ShortTermMemory	2	10	20	N	% in each Decile
43	A:Percept.Speed	2	10	20	N	% in each Decile
44	A:Mech.Comprehen.	2	10	20	N	% in each Decile
45	A:Eye-Limb Coord.	2	10	20	N	% in each Decile
46	A:MovementJudgmt.	2	10	20	N	% in each Decile

Record Size=	819
Number of Records=	10
Est. File Size=	8,190

Table 50-2.2.1. Project A Soldier Task Performance "LV" File

(One Record all MOS, one record nine MOS in CV Subpopulation)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	8	1	8	C	Record Key
2	A:Task-1 Score	2	10	20	N	% in each Category
...	...		...	...	...	
18	A:Task-18 Score	2	10	20	N	% in each Category
19	Last Change Date	8		D		YY/MM/DD Format

Record Size- 348
Number of Records- 10
Est. File Size- 3,480

Table 50-2.2.2. Project A Soldier Task Identification "LV" File

(One Record all MOS, one record nine MOS in CV Subpopulation)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	8	1	8	C	Record Key
2	A:Task Number	2	17	34	N	CV Task Field Number
3	A:Description	500	17	3500	C	Behavior/Procedure

Record Size- 3,542
Number of Records- 10
Est. File Size- 35,420

Table 50-3. MOS Qualifications File

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	3	1	3	C	Record Key
2	PULHES Code	6	1	6	C	AR Extract
3	Color Vision	1	1	1	C	AR Extract
4	Sec. Clearance	3	1	3	C	AR Extract
5	Aptitude Codes	2	5	10	C	AR Extract
6	Related DOT Codes	7	5	35	C	AR Extract
7	Related FCS Codes	7	5	35	C	AR Extract
8	"Must Know" List	256	8	2048	C	AR Extract

Record Size-	2141
Number of Records-	100
Est. File Size-	214,100

Table 50-4. MOS/ASI Titles and Duties File

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	3	1	3	C	Record Key
2	MOS Title	64	1	64	C	AR Extract
3	ASI Title	64	1	64	C	AR Extract
4	Summary Text	256	1	256	C	AR Extract
5	Combat Duties	128	8	1024	C	AR Extract

Record Size-	1411
Number of Records-	100
Est. File Size-	141,100

Table 50-5. DOT Code File

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	DOT Code	7	1	7	C	Record Key
2	DOT Title	64	1	64	C	DOT Manual
3	Primary MOS	3	10	30	C	Applicability Keys

Record Size- 101
Number of Records- 200
Est. File Size- 20,200

Table 50-6. FCS Code File

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	FCS Code	7	1	7	C	Record Key
2	FCS Title	64	1	64	C	FCS Manual
3	Primary MOS	3	10	30	C	Applicability Keys

Record Size- 101
Number of Records- 200
Est. File Size- 20,200

Table 50-7. Soldier Population Design Constraint File

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Constraint Name	32	1	32	C	Record Key
2	Constraint Levels	32	8	256	C	Qualitative Terms
3	Constraint Values	10	8	80	N	Quantitative Terms
4	Level Definition	256	8	2048	C	Explanatory Texts
5	Fill-Blank Spec	512	1	512	C	Model Spec Language

Record Size-	2968
Number of Records-	100
Est. File Size-	296,800

Table 50-8. MANPRINT Product 1 Weapon System/MOS Usage File

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Weapon System	64	1	64	C	Record Key
2	Primary MOS	8	8	64	C	Operators
3	Primary MOS	8	8	64	C	Maintenance
4	Primary MOS	8	8	64	C	Support Personnel

Record Size-	256
Number of Records-	100
Est. File Size-	25,600

Table 50-9. Project A/ASVAB Correlations "CV" File

(One record all MOS, one record nine MOS in CV population)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	8	1	8	C	Record Key
2	Matrix Number	3	1	3	N	Record Key
3	Matrix Title	64	1	64	C	Name of Test Battery
4	Row/Col Titles	12	20	240	C	Names of Measures
5	400 Cell Values	4	400	1600	N	Format 0.00
6	Research Notes	1024	1	1024	C	As applicable

Record Size- 2939
Number of Records- 10
Est. File Size- 29,390

Table 50-10. ASVAB/Project A "LV" Correlations File

(One record all MOS, one record nine MOS in LV population)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Primary MOS	8	1	8	C	Record Key
2	Matrix Number	3	1	3	N	Record Key
3	Matrix Title	64	1	64	C	Test Battery Names
4	Row/Col Titles	12	20	240	C	Names of Measures
5	Cell Values	4	400	1600	N	Format 0.00
6	Research Notes	1024	1	1024	C	As applicable

Record Size- 2939
Number of Records- 10
Est. File Size- 29,390

Table 50-11: ASI Code File

(One Record for Each ASI Code)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	ASI Code	2	1	2	C	Added Skill ID
2	ASI Title	64	1	64	C	AR Extract
3	Primary MOS	3	10	30	C	Applicability

Record Size-	96
Number of Records-	100
Est. File Size-	9,600

Table 50-12: Annual Soldier Accessions File

(One Record for each Training/Enlistment MOS)

Field	Dictionary Name	Size	Values	Total	Type	Comments
1	Training MOS+FY	8	1	8	C	Record Key
2	Population Size	6	1	6	N	Number Holding MOS
3	Males, Females	2	2	4	N	% of Population
4	Age Group	2	12	24	N	% in 3-Year Groups
5	Years of Service	2	12	24	N	% in 3-Year Groups
6	Pay Grade	2	14	20	N	% in each Pay Grade
7	Racial Group	2	6	12	N	% in each Race Group
8	Ethnic Group	2	22	44	N	% in each Category
9	Years of School	2	12	24	N	% in each Category
10	Educ.Certificate	2	16	32	N	% in each Category
11	College Major	2	32	64	N	% in each Category
12	Citizenship	2	5	10	N	% in each Category
13	Weight Lift	2	7	14	N	% in each Category
14	Physical Category	2	6	12	N	% in each Category
15	Physical Stamina	2	4	8	N	% in each Category
16	Upper Extremities	2	3	6	N	% in each Category
17	Lower Extremities	2	3	6	N	% in each Category
18	Hearing	2	4	8	N	% in each Category
19	Eyesight	2	2	4	N	% in each Category
20	5 Senses	2	3	6	N	% in each Category
21	Native Language	2	2	4	C	% English/Other
22	Enlistment Term	2	7	14	N	% in each Category
23	Army Service Type	2	5	10	N	% in each Category
24	AFQT Category	2	9	18	N	% in each Category
25	AFQT Score	2	10	20	N	% in each Decile
26	Clerical Aptitude	2	10	20	N	% in each Decile
27	Combat Aptitude	2	10	20	N	% in each Decile
28	Elect.Aptitude	2	10	20	N	% in each Decile
29	Fld.Art.Aptitude	2	10	20	N	% in each Decile
30	GenMaint.Aptitude	2	10	20	N	% in each Decile
31	Gen.Tech.Aptitude	2	10	20	N	% in each Decile
32	Mech. Aptitude	2	10	20	N	% in each Decile
33	FoodSvc Aptitude	2	10	20	N	% in each Decile
34	PMOS SQT Score	2	10	20	N	% in each Decile
35	SurvComm.Aptitude	2	10	20	N	% in each Decile
36	Tech.Aptitude	2	10	20	N	% in each Decile

Record Size-	622
Number of Records-	100
Est. File Size-	622,000